SURFACE TRANSPORTATION R&D

HEARINGS

BEFORE THE

SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

OF THE

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SURFACE TRANSPORTATION R&D

WEDNESDAY, APRIL 10, 1991

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:36 a.m. in room 2325, Rayburn House Office Building, Hon. Tim Valentine [chairman of the subcommittee] presiding.

Mr. VALENTINE. Welcome, ladies and gentlemen. We'll get started.

I want to say for the benefit of the members who are seated here that the impressive array facing us is only one witness. The rest of them have answers to the questions.

The history of surface transportation provides an accurate record of a society's technical progress. Roman chariots and Viking sailing vessels provided significant advancements in mobility. Symbolically,the Japanese and Europeans plan to challenge us for the America's Cup, stating it will be a measure of national technical superiority.

The United States is a nation on wheels with an estimated 185 million vehicles currently in use. Our transportation of goods is unprecedented and provides us with rapid delivery of food and manufactured goods. Our transportation system is an integral part of our economic infrastructure.

In spite of this current strength, there are still concerns about our future ground transportation systems. These concerns include the high accident rate problem, inflexibility to readily increase capacity, environmental degradation, higher user costs and excessive petroleum consumption.

This Subcommittee plans to examine the technologies associated with transportation in the context of our country's capacity to be competitive. Are we equal to other industrial nations? Are we gaining or falling behind in terms of the development and deployment of new transportation technologies?

We believe it is important to ask several questions about our future decisions. What new technologies should be pursued? Where should we concentrate our research and development resources? Should we invest in Mag-Lev and if so, in what manner? What is the potential for new systems to be accepted by the public? Of course, how can we pay for new systems?

There are a number of exciting opportunities to significantly modernize our suburban/urban transportation systems for the future. Each transportation opportunity must be weighed against

the long-term contribution it can potentially make in enhancing economic prospects and general quality of life.

Today, we will receive testimony on policy matters that can affect the transportation systems of tomorrow. Next week, on April 16, we will receive testimony on the state of various technologies, their maturity, and the need for additional research and development.

The Chair recognizes at this time, the distinguished Ranking member of the Subcommittee, Mr. Tom Lewis from Florida.

Mr. LEWIS. Thank you, Mr. Chairman.

In the 1950s, the era of longer, faster U.S. cars, we dominated the world's automotive industry. The statement was often made that General Motors was so large that the chances of going broke were about the same as the U.S.S.R. going broke. Today, the cars are shorter and safer, but the U.S. lost its competitive edge and U.S.S.R. may go broke before General Motors.

The purpose of these three hearings is what research would restore U.S. automotive technology competitiveness? Could the U.S. industry regain the leadership position in automotive technology advancements.

The Department of Transportation is mandated by Public Law 89-670 to stimulate technological advances in transportation, promote and undertake research, and development relating to transportation. I want each witness over the three hearing days to answer the question, what is DOT doing to stimulate technological advances in transportation and what should they be doing? I also want to hear what research each witness believes could be conducted to enhance U.S. automotive competitiveness.

Thank you, Mr. Chairman.

Mr. VALENTINE. Thank you, sir.

The Chair recognizes the distinguished member from the State of Michigan, Ms. Barbara Collins? If you have an opening statement, we'll be happy to hear from you.

Ms. COLLINS. Not really, Mr. Chairman. Thank you very much for recognizing me. I'm pleased to be here and I'd like to hear the testimony today. I hope that the testimony will deal with the many auto fatalities that we have in this country, last year more fatalities than the Vietnam War. I hope that some of the testimony will deal with fatigue, drivers having fatigue and causing fatal accidents.

I'm sure that this hearing will be very enlightening to me, Mr. Chairman. Thank you.

Mr. VALENTINE. Thank you.

The Chair will recognize at this time the distinguished member from the State of Michigan, Mr. Paul Henry, one of the House's more illustrious graduates of Duke University.

Mr. HENRY. Thank you, Mr. Chairman, and I share your joy over the results of the basketball tournament.

I want to commend my Ranking member and the Chairman for their opening statements and simply say that a real concern here has been the seeming lack of real leadership in the Department and its abilities under the Surface Transportation Act to take proactive initiatives right into the engineering and manufacturing infrastructure of the American automotive industry.

Ten years ago we still had favorable balance of trade in automobiles. Now we have about a $60 to $80 billion annual deficit in the balance of trade in the auto industry. It doesn't take great intelligence to understand the significance of that in terms of our manufacturing base, the health of our economy, and in our questioning period which will follow, I hope to really focus on those issues.

I was just last week in the old Trabant factory in Nice, Germany. We laugh at Trabant because we see what the communists did to engineering in the eastern sector. What I was surprised to find out was the history of that plant and the same people who now produce BMW in the west. In the late 1930s and early 1940s, these people were manufacturing for commercial sale automobiles in the same factory that had highway capacities of 220 miles a hour, reached 120 miles a hour in first gear. In other words, we never really had some of the technological supremacy we assumed we had. We gained a tremendous market advantage at a period in time given the results and impact of World War II.

If anything struck me as we went through the museum and talked to some of the older engineers who knew what they were doing in those days, the markets were less global, the automobile was just beginning to become a middle class instrument of transportation, and it was in that post-war period we enjoyed a kind of supremacy that may have been an accidental gift. Very clearly, they were well ahead of us even at that point in time in terms of some of the engineering skills.

This is a very, very important issue and I want to get beyond such issues—not to diminish them simply in terms of highway design, fatality issues—I agree with Ms. Collins in terms of the importance of that and we are very pleased in terms of what we have achieved in highway safety in this country compared to any other industrialized, auto-dependent country in the world. Our statistics are overwhelmingly better, significantly even better than Canada which is a nation which most closely mirrors us in highway fatality injury data.

In terms of possibilities of the Department under this Act of reinvigorating through partnerships with industry, your Department and the scientific community, a wholehearted attack on engineering and technology infrastructure will help us reestablish ourselves commercially.

Mr. Chairman, I would hope that because of the very limited amount of time we have, given the fact that we are following with the markup, perhaps it would be appropriate to ask those who are before us giving testimony to summarize their statements so we could get into the meat of the discussion and leave that to the discretion of the Chair, but I think we've been rather successful these last few months in trying to adopt this new procedure.

Thank you, Mr. Chairman.

Mr. VALENTINE. Thank you.

The Chair recognizes Mr. Swett?

Mr. SWETT. Thank you, Mr. Chair.

I thank you for spending this time with us this morning. As you've just heard, we have many, many issues that are before us. I will be brief and try to add only a perspective that I have because

of the geographic and demographic makeup of my constituency and also because of my professional background.

I hope that as you discuss the issues of high technology and competitiveness as it relates to surface transportation, you will remember that rural districts are equally important in many respects, more important because of the efficiencies that need to be exacted in this area and that is one that I certainly will be listening very carefully to hear you talk about.

Secondly, I also believe very strongly that alternative fuels is a very important area of research and development that, in my mind, carries with it a high technology description and this applies not only to electric vehicles but to natural gas and hydrogen utilization. I hope that as you speak, you will be able to incorporate experiences, thoughts and projections as to how these particular technologies might also be incorporated.

Beyond that, I am eager to hear your testimony and I thank you once again for coming.

Thank you, Mr. Chair, for holding this hearing.

Mr. VALENTINE. Thank you, sir.

Our first witness is Mr. Mark Dowis, Associate Administrator for Research, Technology, and Analysis, Research and Special Programs Administration, U.S. Department of Transportation. It has been suggested, we would request that you summarize your remarks, please, sir, hopefully with the span of 10 minutes. We have several witnesses. Your prepared statement will appear in the record as presented to us.

STATEMENT OF MARK DOWIS, ASSOCIATE ADMINISTRATOR FOR RESEARCH, TECHNOLOGY, AND ANALYSIS, RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION, U.S. DEPARTMENT OF TRANSPORTATION; ACCOMPANIED BY: WILLIAM A. LEASURE, JR., DIRECTOR, OFFICE OF CRASH AVOIDANCE RESEARCH, NATIONAL HIGHWAY SAFETY ADMINISTRATION; CHARLES L. MILLER, ASSOCIATE ADMINISTRATOR, FEDERAL HIGHWAY SAFETY ADMINISTRATION; DENNIS C. JUDYCKI, ASSOCIATE ADMINISTRATOR FOR SAFETY AND SYSTEM APPLICATIONS, FEDERAL HIGHWAY ADMINISTRATION; ROBERT L. KRICK, DIRECTOR, DEPUTY ASSOCIATE ADMINISTRATOR, TECHNOLOGY DEVELOPMENT, FEDERAL RAILROAD ADMINISTRATION; AND LAWRENCE L. SCHULMAN, ASSOCIATE ADMINISTRATOR, URBAN MASS TRANSPORTATION ADMINISTRATION

Mr. DOWIS. Good morning, Mr. Chairman and members of the committee.

What you see before you is not in fact the new starting lineup of the Washington Nationals but in fact, a carefully crafted strategy to show you how R&D gets done at the Department of Transportation. I'll leave you to draw your own conclusions.

I'm very pleased to be here before you today to share the vision of the U.S. Department of Transportation for future transportation systems. I'm accompanied today by Mr. Charles Miller and Mr. Dennis Judycki of the Federal Highway Administration; Mr. Robert Krick of the Federal Railroad Administration; Mr. Lawrence Schulman of the Urban Mass Transit Administration, and fi-

nally, Mr. William Leasure of the National Highway Traffic Safety Administration.

The U.S. Department of Transportation's Research and Special Programs Administration serves as the advocate for research in the Department's budget process. We administer programs to facilitate multimodal operations and to preserve transportation safety.

We also provide leadership and staff support for the Department's Research and Development Coordinating Council which sets the direction for the Department's overall research program. Many of DOT's current directions have been established in response to the statement of national transportation policy which was issued last year.

The policy charted the direction for federal transportation programs into the 21st century and reemphasized the role of research in the conduct of DOT's business. It includes some specific commitments to perform or to promote research on important, future-oriented topics such as intelligent vehicle highway systems, and short haul passenger transportation systems among others.

Investment in DOT's R&D activities have resulted in products which benefit the entire transportation community. The results of the Strategic Highway Research Program are a good example of this. Nevertheless, we recognize that there is room for improvement. A key part of our initiative has been the institution of a formal R&D management process within the Department.

A formal R&D policy statement, which I will be glad to provide for the record, directs this program [See Appendix]. Its appendix is a R&D program agenda which summarizes the highest priority R&D projects. We used this R&D agenda last summer in a pilot screening of the Department's fiscal year 1992 R&D budget requests prior to their submission to the Office of Management and Budget.

Our pilot R&D priorities exercise highlighted the need for better communication across modal lines when developing multimodally applicable technologies. We have set up a series of eight working groups under the R&D Coordinating Council dealing with human factors, radio navigation, transportation and the environment, transportation and economic growth, intermodal transportation facilities, transportation technology sharing, transportation data, and finally, intelligent vehicle highway systems. A ninth group is being considered for security and intelligence issues. These groups are hard at work conducting multimodal research planning, sharing the results of ongoing research, and developing cooperative strategies to disseminate research results.

I would now like to highlight several key DOT research initiatives which address challenges put forward by the National Transportation Policy.

One of the most visible is intelligent vehicle highway systems, IVHS, the so-called smart cars and highways. The technologies of these systems are an evolution of technologies in use today. Examples of these are cruise control and variable freeway message signs. IVHS technology will enable us to simultaneously improve highway safety and use the existing highway infrastructure more effectively.

Users of private motor vehicles, motor carriers and public transportation will all benefit. IVHS will help prevent traffic jams from occurring and lessen their length and intensity when they do. There should also be a reduction in environmental impact and better services to elderly drivers.

The Department's activities are one element of a broader set of cooperative activities with the private sector focused through the newly-created IVHS America Group. U.S. tests of technologies are forthcoming and include the Pathfinder Project in California and the TRAVTEK Project in Florida just to mention two. RSPA is also promoting the use of the new global positioning system by IVHS systems. Instituted for military purposes, the signals from GPS satellites can be used by any vehicle to precisely establish that position with unprecedented accuracy.

DOT is also focusing on options to serve passenger trips in the 100 to 500 mile range. The National Transportation Policy highlighted a possible role for magnetically levitated or Mag-Lev trains in these markets.

In fiscal year 1989, the Department's Federal Railroad Administration began researching standards pertaining to Mag- Lev safety. Federal issues include not only safety but also standardization, long term planning, including national interstate routing and compatibility with existing modes of transportation.

An interagency Mag-Lev Coordinating Committee which includes the Department of Transportation, the Army Corps of Engineers, the Department of Energy and the Environmental Protection Agency guide these studies. Under the leadership of FRA, multimodal teams work on projects dealing with market and economic analysis, vehicle systems, guideways and control systems, and system integration. Separate projects focus on high speed rail technologies.

The Department is also working to develop an even more effective set of partnerships with the university community on transportation research. We are expecting increased benefits from the University Transportation Centers Program and are insuring that its activities are coordinated with the overall DOT R&D program.

The UTC program is now being transferred to RSPA. We have been working closely with the center directors to better integrate their programs and to bring a greater diversity of research talent to the centers. We are also improving the Department's mechanisms to make the results of our research available to the transportation community in useful form.

There are a variety of channels in the Department doing that with the Office of Research Policy and Technology Transfer overseeing the complex network. These efforts will assure that the knowledge base we are developing will move the United States into the next century as a world leader in transportation technology.

This completes my prepared remarks. We'll be happy to answer any questions you might have.

[The prepared statement of Mr. Dowis follows:]

STATEMENT OF
MARK C. DOWIS
ASSOCIATE ADMINISTRATOR FOR RESEARCH, TECHNOLOGY AND ANALYSIS
RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION
U.S. DEPARTMENT OF TRANSPORTATION

BEFORE THE
HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

CONCERNING
RESEARCH AND DEVELOPMENT POLICY IN
THE U.S. DEPARTMENT OF TRANSPORTATION

Mr. Chairman and Members of the Committee:
I am pleased to appear before you today to share the vision the United States Department of Transportation has for future surface transportation systems, and the course which will take us there. I am accompanied today by representatives of the Federal Highway Administration, the Federal Railroad Administration, the National Highway Traffic Safety Administration, and the Urban Mass Transportation Administration.

Within the U.S. Department of Transportation the Research and Special Programs Administration (RSPA) serves two related and important roles. In addition to administering diverse programs to facilitate multimodal operations and preserve transportation safety, we also provide the leadership and staff support to the Department's R&D Coordinating Council. This body, which consists of the senior official with research responsibilities in each of the operating administrations, helps set the directions and policies for the Department's overall research program. RSPA's Office of Research Policy and Technology Transfer devotes a significant amount of its time to supporting this group. RSPA also serves as advocate for the role of research in the budget processes of the Department.

As Associate Administrator for Research, Technology, and Analysis, I am deeply involved in both aspects of RSPA's R&D role. RSPA Administrator Travis Dungan chairs the R&D Council. In that role, he works with the senior R&D managers of the Department to help establish research policy and program directions on a Department-wide basis. Many of these directions have been established in response to the Statement of National Transportation Policy issued last year. The Policy was formulated on a solid technical base, building heavily on the analyses in the National Transportation Strategic Planning Study. Required by the 1988 Department of Transportation Appropriations Act, this study was designed to forecast long-term needs and costs for developing and maintaining the transportation system out to the year 2015. An entire chapter was devoted to examining the prospects of finding technology solutions to current and prospective transportation problems. The data contained in this document provided a detailed and rich backdrop against which the National Transportation Policy was formulated. Much of the material was developed in multimodal analyses conducted at RSPA's Volpe National Transportation Systems Center located in Cambridge, Massachusetts.

The National Transportation Policy charted the direction for Federal transportation programs into the next century under six major themes:

1. Maintain and expand the Nation's transportation system
2. Foster a sound financial base for transportation
3. Keep the transportation system strong and competitive
4. Ensure that the transportation system supports public safety and national security.
5. Protect the environment and the quality of life
6. Advance U.S. transportation technology and expertise

The National Transportation Policy provides a long-needed re-emphasis on the role of research and technology in the conduct of

DOT's business, and makes some key redirections and new starts. It lengthens the Administration's time horizon into the Twenty-First Century, at the same time assuring that shorter-term needs are being dealt with. It sets out a series of principles detailing the proper role of the Federal government in supporting research and technology projects, emphasizing the need for full involvement of the private sector, university community, and other levels of government in research agenda-setting, conduct, and funding. It includes some specific commitments to perform or promote research and technology projects on important, future-oriented topics: intelligent vehicle/highway systems, human factors, short-haul transportation options, and data to support transportation decision-making, among others. The National Transportation Policy precisely outlines the course to take this nation's transportation system into the future, and the research that will be needed to get there.

Nationally and internationally the public and private sectors are increasing research efforts to provide technologies that address identified needs. Results of these efforts must be put into practice quickly and widely to:

- Benefit the Nation's transportation system
- Improve the United States technical presence abroad
- Ensure the best return possible on the investment in research and development.

Complementing these expanded research efforts is an expanded program of technology assessment and deployment. Activities in this area address timely implementation of research results. Past efforts of this type have proven extremely cost-effective. For example, the successful promotion of an FHWA-developed technology that provided a new method to design pile foundations is resulting in savings of $120 million annually.

The investments in R&D result in products which improve system performance and operations for the entire transportation community. For instance, the Strategic Highway Research Program (SHRP) is coming to a close and already 96 products resulting from this five year, $150 million research program have been identified. SHRP is a legislatively authorized program of highway research jointly administered by FHWA, the Transportation Research Board, and the American Association of State Highway and Transportation Officials. The FHWA has the responsibility for SHRP product implementation and work is currently underway planning details of the FY 1992 program. This is being done cooperatively with SHRP, and will initially focus on the immediate and near-term products with particular emphasis on asphalt, cement and concrete, highway operations, and pavement performance.

Although there has been progress, we have recognized the need for procedures to administer research projects more effectively. We have been improving the way that DOT manages and monitors its R&D. A key part of this initiative has been the institution of a formal R&D Management process in the Department, developed to operate through the R&D Council. This intermodal system was developed by RSPA's Office of Research Policy and Technology Transfer, with the full cooperation and encouragement of the Assistant Secretary for Budget and Programs.

To clearly establish the directions for this process, we compiled a formal R&D Policy Statement, which I would be glad to provide for the record. The appendix to this document is a multimodal R&D Program Agenda, which summarizes the highest priority R&D projects for the Department at the present time. The Department used this R&D Agenda last summer on a pilot basis to screen the Department's FY 1992 R&D budget requests prior to their submission to the Office of Management and Budget. I should also note that many operating administrations have developed their own five-year, more detailed

research and technology agendas to seek, develop, and apply the desired innovations and advanced technologies.

Our pilot exercise to link R&D explicitly to DOT's program priorities highlighted several areas that needed improvement. One particular need was to provide a better forum for communication across modal lines in the Department when several administrations were developing technologies of interest and relevance to several others. I was particularly interested in making some progress here, since RSPA has responsibility to provide leadership in developing intermodal perspectives on research issues. In the operational R&D management system we are now implementing, we have set up a series of eight working groups under the R&D Coordinating Council dealing with crossmodal or multimodal topics highlighted in the policy.

These groups are hard at work, and have already become an important vehicle for administering and monitoring transportation research on a truly intermodal basis. They deal with the following topics:

- Human factors
- Radionavigation
- Transportation and the environment
- Transportation and economic growth
- Intermodal transportation
- Technology sharing/transfer
- Transportation data
- Intelligent vehicle/highway systems (IVHS).

A ninth group on Intelligence and Security is being considered. These groups include representatives of all DOT elements conducting research which is relevant to the group topics: this makes possible coherent multimodal research planning on a number of topics of critical importance to the Department.

Each working group provides a multimodal forum for coordinated R&D planning, a communication channel to share the results of ongoing research, and a vehicle to develop effective strategies to disseminate research results. They will play a pivotal role in making sure that the research programs funded in the Department deliver products of relevance and use to the Department and the transportation community.

I would now like to highlight several key research and technology initiatives undertaken by DOT. One of the most visible deals with Intelligent Vehicle/Highway Systems (IVHS), the so-called "smart" cars and highways. IVHS is one of the most exciting and productive avenues we see to make the best use of the existing infrastructure. IVHS will benefit users of private automobiles, motor carriers, and public transportation alike. The technologies being developed for these systems are the descendants of technologies we are using today, including things like cruise controls in cars and variable message signs on freeways that warn motorists of developing jams. They are continuations of trends that are already influencing the design of highways, automobiles, buses and trucks.

With IVHS systems come the prospects of marked improvements in highway system safety. The various elements of IVHS technology will enable us to move more people and freight on available roadway more safely, yet without having to construct as many new lanes as we would otherwise. The vehicle management technologies will help prevent traffic jams from occurring, or lessen their length and intensity when they do. The technologies will reduce the environmental impacts of motor vehicles simply by lessening the time they are caught on the road in traffic jams. The systems will be particularly useful for older drivers, helping them compensate for slowed reaction times and other effects of aging. And, maybe most important, they enable us to responsibly maintain the personal mobility that much of our society is structured around today.

The United States is not alone in actively pursuing the IVHS concept: both Japan and Europe have active programs with some degree of government involvement to develop these technologies. One of the most prominent European initiatives is PROMETHEUS, which stands for Programme for European Traffic with Highest Efficiency and Unprecedented Safety. This eight year, $800 million initiative began in 1986, and is aimed at developing a uniform European traffic system incorporating IVHS technology.

The Japanese have two major IVHS programs: Advanced Mobile Traffic Information and Communication System (AMTICS) and Road-Automotive Communication System (RACS). Both of their programs emphasize communications and traffic control. With the confirmed high level of activity with basic IVHS technologies in world markets, it is important to establish and retain U.S. leadership.

The United States has initiated a cooperative government/private sector effort, working with the close cooperation of the newly-created IVHS America organization, to take the lead with IVHS. IVHS America has been constituted as an advisory committee to the Department, and funded pursuant to Congressional direction. DOT's work is just one component of a much broader national effort. A number of tests of IVHS elements in the U.S. are already ongoing or ready to proceed. These include:

- The PATHFINDER project, a 25-vehicle field evaluation of an in-vehicle navigation and information system in the Santa Monica Freeway Corridor in Los Angeles. It is being cosponsored by FHWA, the California DOT, and General Motors.
- The "GuideStar" program, in which 300 miles of freeways and major arterials will be connected to and monitored by a real-time regional traffic management center by 1995. The initial focus of the program is on advanced surveillance technology. FHWA, Minnesota Department of

Transportation, and the University of Minnesota are cooperating on the project.

- The TRAVTEK project, which will provide route guidance and innovative motorist information services to 100 vehicles equipped with in-vehicle devices in the area around Orlando, Florida. Cooperating sponsors include U.S. DOT, the State of Florida, the City of Orlando, General Motors, and the American Automobile Association.
- The Crescent and Advantage I-75 projects, which are testing the automation of the process of commercial vehicle identification. Crescent is part of the Heavy Vehicle Electronic License Plate (HELP) project, and includes participation by the states of Washington, Oregon, California, Arizona, New Mexico, and Texas. Advantage I-75 will test Automatic Vehicle Identification (AVI) technology along I-75 in Florida, Georgia, Kentucky, Texas, Ohio, and Michigan. Both Crescent and Advantage I-75 include Canadian partners, as well.
- An effort in the New York/New Jersey area that is examining the application of automatic vehicle identification technology for automatic toll collection and traffic management purposes.

DOT will be working with industry to develop an advanced driver simulator to perform necessary IVHS evaluations. This will be an important step in allowing human factors research capability to catch up with the development of information processing and advanced vehicle-related technology. The Urban Mass Transportation Administration is also working, through its Advanced Public Transportation Systems Program (APTS), to assist the public transit industry in developing operational tests that evaluate the benefits and costs of IVHS technologies. Current UMTA efforts focus on market development, customer interface, vehicle operations and communications, and high-occupancy vehicle preference.

In addition to recent and proposed initiatives in IVHS, RSPA has a longstanding role in promoting use of the Global Positioning System (GPS) now coming on line for civil sector users. Originally instituted for military purposes, the signals transmitted by the GPS satellites can also be received by civilian vehicles, and used to establish their positions more exactly than with any previous system. The technology therefore looks particularly attractive to support IVHS positioning requirements, as well as other surface transportation purposes. Some of the satellites are already operating, and it's just smart to use the system as it becomes available.

In fact, if I had to establish a theme for our current R&D, "smart" would be an accurate characterization. It is time to fully integrate the computer revolution into transportation technology, along with advances in materials, communications systems, propulsion systems, and system management strategies. The research we propose is aimed at making the best use of the resources we already have in place, taking advantage of new opportunities when they present themselves, and helping the transportation community to apply the advances. It is irresponsible to do anything else, considering fiscal realities and the alternative uses for the resources we are requesting.

Our transit research program is a good example of this philosophy in action. The Urban Mass Transportation Administration is currently redirecting its research and technology activities to reflect new priorities. Where in the past research was directed at revolutionary changes and new technology focused on major systems, today's program emphasizes manageable changes to the existing transit system, such as advances in component technologies and innovative operational techniques. The program will seek partnerships with suppliers, manufacturers, and transit operators interested in innovation, and willing to commit both personnel and financial resources in seeking solutions to industry problems. In

addition, the program will address a range of critical issues, including congestion management and implementation of the Americans with Disabilities Act.

We are also taking major steps forward in assessing and developing options to meet future needs. As highlighted in the National Transportation Policy, magnetically levitated systems, or so called MAGLEV trains, are one option to serve passenger trips in the 100 to 500 mile range: the trips that are too far to drive easily and too short to fly on conventional airliners.

In FY-1989 the Department's Federal Railroad Administration began a systematic research effort reviewing standards pertaining to MAGLEV safety. The Federal Government has an important interest in encouraging standardization, long term planning including national interstate routings, and compatibility with existing modes. FRA is now attempting to assess the appropriate role of MAGLEV in the U.S. transportation system. An Interagency MAGLEV Coordinating Committee, which includes DOT, the Army Corps of Engineers, the Department of Energy, and the Environmental Protection Agency has developed a plan to examine the technological, safety, economic, and financial factors involved. Elements of the FRA work deal with market and economic analysis, vehicle systems, guideway and control systems, and systems integration. A separate set of projects focuses on conventional high speed rail technologies to develop the needed safety requirements and regulations for their operation in the United States.

Again following up on the National Transportation Policy, the Department is expecting substantial benefits from the University Transportation Centers Program, and ensuring that the program activities are coordinated with the overall DOT R&D program. The program is being transferred into my organization, which has oversight of all the research conducted by the Department. Travis

Dungan and I have been working closely with the Center Directors to further integrate their ten programs into a cohesive whole.

In addition to strengthening the existing Centers, we are planning to establish three new Centers. These new Centers will address issues of national concern, such as an increased emphasis on mass transit and highway safety research, and will bring a greater diversity of research talent to the program. We have already initiated efforts in our Technology Sharing program to provide greater emphasis and support to the products from this program.

Without the ability to get research into the hands of users the research process ultimately fails. With this in mind, we are improving our mechanisms to make the results of DOT research available to users in the transportation community in comprehensible and relevant form. There are a variety of channels in the Department doing this, with my Office's Technology Sharing activity overseeing the operation of this complex network. We have been particularly aggressive in promoting use of the Department's laboratories in the technology transfer process as required by the Stevenson-Wydler Act. Technology Sharing also conducts its own outreach activities, focusing particularly on the needs of state and local policy officials and decision makers.

Two other successful outreach channels for the Department have been the Rural Technical Assistance Programs administered by FHWA and UMTA. Each of these programs focus on the needs of local users and operators, and have been particularly responsive to their needs. We intend to continue these important technical assistance services, and are using them as a model for services to provide improved access to technologies for urban transportation agencies. The new urban services would build on the lessons learned in rural areas.

The research and technical assistance activities conducted by DOT are a comprehensive effort to develop needed technologies for the future, and make sure that they are available to the elements of the transportation community who need to use them. The knowledge base we are developing will help us move into the Twenty-First Century as a world leader in the full range of transportation technologies.

This completes my prepared remarks. We will be happy to answer any questions you may have.

Mr. VALENTINE. Thank you, sir.

Mr. Dowis, I have four general questions and maybe some subquestions. I'll begin at the end of the list that I have here and ask you this question about the IVHS intelligent vehicle highway system which is a rather amazing concept and boggles the imagination to think of this system in operation in the United States, given the population and the vastness of the public.

Say that we make outstanding progress in this direction, what does the development of this system do with respect to— what are the problems with respect to highway safety and the people who still choose to operate on the highways while impaired?

It's probably not a good analogy, but liken it to intelligent weapons that we have recently seen in use. It takes a lot of smarts and a sober mentality to aim a smart vehicle. It doesn't take that much judgment to pick up a rifle and the iron sights. Suppose we had the IVHS system that went up and down the eastern seaboard, how could that be impacted by the introduction of persons driving under the influence?

Mr. DOWIS. Well, sir, first off, I would like to say that outstanding progress is already being made in IVHS. There are a number of initiatives going on in the Federal Highway Administration in concert with UMTA and NHTSA which we believe are a credible down payment on the future.

In answer to your specific question about the impaired driver, one of the advantages and one of the cornerstones of the IVHS program in the Department is safety as well as congestion management and mitigation of congestion. The specifics of how the system would operate with the impaired driver are obviously something that NHTSA in particular would be dealing with, but the idea behind this is at some levels, to almost get a drive by wire type system like you have in some airplanes now wherein you have almost a hands-off.

In essence, what would happen would be the impaired driver would perhaps have less impact or Bill, why don't you take a crack at this one?

Mr. LEASURE. I think the point that has to be made here is that obviously we don't have a system yet, so I can't give you a specific as to how it could operate but we could go through a couple of scenarios.

First of all, the difficulty we have in crashes today are a result of driver error; 79 percent of the crashes today happen as a result of driver error. That could be impairment or it could just be inattention or incorrect maneuvers. So what we have to address in the safety issue certainly is to assist the drivers, to provide him with additional warnings to enhance his senses in acknowledging situations exist, and then to take over and provide him with either assistance or actually control the vehicle.

IVHS systems conceivably the technology is there to allow us to do that. They could range anywhere from simple reminders that you're not being attentive, you shouldn't be driving, all the way up to something that could stop him or her from driving his or her vehicle if under the influence or impaired.

Mr. VALENTINE. I don't mean to suggest that this problem ought to be of sufficient importance to slow down the research and devel-

opment but it is a real problem, isn't it, because if you've got a buzzer system to tell the guy, you're too drunk to be driving, they told him that when he left the party. Anyway, I won't belabor that.

Let me ask you a couple of other questions about that system. What has the Department done to develop the standards? I take it that would be absolutely essential; it would be like having the same rail gauge from state to state, you couldn't have a system that operated in Georgia different from what operated in New York State?

Mr. DOWIS. The standard is obviously a very key question to the Department. I would like to make a general statement about it and then hand it over to the gentleman from Federal Highway.

At some levels, as with all transportation, the private sector is really the driving force behind; these are the people who move the goods, who need the set up just in time delivery system which allow them to track.

Through the IVHS America Group, the Department—which by the way is being used as an official advisory group for the Department—is attempting to work with the industry to set standards. It's the belief of the Department that the marketplace often sets better standards than some federally- mandated standards.

Charlie, would you like to take a shot?

Mr. MILLER. Mr. Chairman, if I might, the whole concept of intelligent vehicles, smart highway approach to traffic safety and congestion is one that kind of moves across a graduated scale from the simplistic to a much more sophisticated scale.

I think we need to think in terms of the simplistic first in terms of what it can really do for us. First, in terms of safety, for example, it was estimated that 50 percent of all rear end collisions, for example, could be avoided if the driver had just one-half a second more warning that something was going to be in his path,. Say the errant or impaired driver is crossing the center line or entering the intersection illegally. Head-ons could perhaps be 30 percent reduced by that half-second additional warning.

That's not really terribly high tech stuff. That technology is there. It simply means that we need to apply it to our vehicles. Is that intelligent vehicle more highway technology, yes, it is, but it is not necessarily of the sophistication. At this juncture in terms of standards, the research that is currently ongoing and the field trials that are currently ongoing, Mr. Judycki can speak to in more detail, are current projects to establish, for example, the protocols for communication, for guidance and for things of that nature.

Dennis, you might want to speak to that.

Mr. JUDYCKI. Mr. Chairman, I think that another very important safety aspect of IVHS is in fact that today over half of the fatalities in this country are in fact the cause of runoff the road or head-on collisions. In addition to Mr. Miller's comment about information to the driver in a quicker fashion, lateral guidance systems will provide us a great deal of potential.

Even with today's technology or information to motorists through changeable message signs and today's system and technology through freeway incident management programs, we could make a great stride in advancing both mobility and safety.

From the standards perspective, I think it's important to recognize that IVHS is in an embryonic stage right now. We've moved very quickly to put a program together over the last three or four years and later this morning, you'll be hearing from Mr. Lamm more about IVHS America which in fact has been incorporated as the national organization to set the tone, the stage and the program for a cooperative IVHS program for this country.

We have, in the Department, recognized IVHS America as an advisory committee to us and are working closely with them. IVHS America had its first annual meeting just a couple of weeks back and after expecting about 250 participants, there were 507 people that registered, and there's been a tremendous response through corporate memberships to this very important initiative.

We in IVHS America are going to be putting together a strategic plan over the next few months to address how we should move forward in this country with the IVHS program. As part of the IVHS program structure, there is in fact committee structure that will address the standards and protocol issues.

Much of the technology that's now being advanced through and tested and evaluated through operational tests in this country in fact will have to be viewed from a basis of which standard should apply and we are all very aware of that and will be addressing that with IVHS America in partnership with industry.

Mr. VALENTINE. Thank you. I have several other questions but I don't want to monopolize that and I will yield at this time to the distinguished Ranking member, Mr. Lewis.

Mr. LEWIS. Thank you, Mr. Chairman.

In the budget request for the Federal Highway Act in 1991 there is reference to a collaborative research development. Within this program there is a reference to the Stevenson- Wydler Technology Act of 1980. What is the nature of the research under this program?

Mr. DOWIS. Under the Stevenson-Wydler Act, the Departments of the Executive Branch are directed to look at and carry forward the concept of cooperative research and development agreements that exist between federal laboratories of which the Department has a number, and also to deal in concert with both their own employees and then also the private sector.

The Office of Research Policy which answers to me has been actively and aggressively pursuing with Mr. Miller's group out at Federal Highway Administration with the Volpe National Transportation Systems Center in Cambridge, Massachusetts, the Tech Center, a process and a procedure to put in place.

We have actually in the case of the Tech Center put in the mechanism for cooperative research and development agreements. The specifics of research under that I think since it's highway, I would like to leave to Charlie Miller who is their Associate Administrator for Research.

Mr. MILLER. Mr. Lewis the role, as we see it for the Federal Government and Federal Highway Administration certainly in this arena, is to really act as a catalyst along with industry to develop those technologies and get them incorporated into the marketplace. That's our basic thrust.

If you look at the proposed legislation under the new Reauthorization Act for 1991, in Section 110, it provides for the authority of the Secretary to engage in research and development activity and produce in a participative way with industry, providing up to, on the average, 50 percent of the cost of research projects in the development of technology to serve in terms of things like IVHS, for example, but certainly not limited to that and cover the other research and development activities associated with surface transportation.

Mr. LEWIS. What is your total budget for 1991? Do you have any idea?

Mr. DOWIS. The total R&D budget for the Department of Transportation—

Mr. LEWIS. And for the Stevenson-Wydler?

Mr. DOWIS. If I could provide that for the record, I don't have that number.

[Information not provided by press time.]

Mr. LEWIS. Very good. I have a question I'd like to ask. If the Department of Transportation in any way in its research has looked at coming up with smart ignition switches instead of keys and a combination of buttons to protect against the DUI situation and also has the Department in its research looked at coming up wit this type of mechanism and also mandating it be part of every automobile?

Mr. DOWIS. Sir, to my knowledge, the Department of Transportation has not funded research for that type of smart ignition system. However, the private sector over the last 10 or 15 years has looked at that and I believe several of the manufacturers have done some test marketing in that. I believe there were some problems with that, but the short answer to your question is no, the Department has not. As to future plans, I would I guess turn to the Federal Highway folks and ask them if you have any plans for that?

Mr. MILLER. No, we do not at this point.

Mr. LEWIS. I'll ask a very academic question. Why not? This is the highest killer on the highways. We're talking about all these other smart systems but we go out and kill people with drunken drivers. Why don't we take a look at something like this? This happens all over this country and I, for one, am getting damned tired of it. I just wonder why there shouldn't be certain things that we are doing. We always seem to shy away from this particular DUI area in aircraft, in automobiles, and everything else.

Mr. DOWIS. Congressman Lewis, I just want to assure you that highway safety and getting impaired drivers whatever the impairment, whether it be drugs or alcohol, is probably the top priority of the Department of Transportation. NHTSA almost solely devotes its resources to that area.

Specific to the technology of development of, excuse me, a gadget which would disbar people from using their personal property, there are a number of obvious legal questions involved in that.

Mr. LEWIS. I know all that.

Mr. DOWIS. So in point of fact, this has not been viewed by the Department as perhaps the highest and best use of its highway safety dollars. We believe, however, that we are spending money in

an extremely credible program and I would just point out the highway fatality statistics per passenger mile tend to support that.

I'm not disagreeing that the number of deaths is an absolute travesty.,

Mr. LEWIS. I don't have any further questions right now.

Mr. VALENTINE. Ms. Rose Collins?

Ms. COLLINS. Thank you, Mr. Chairman.

I do have some questions. Mr. Dowis, you said—I hope I didn't misunderstand you—that the marketplace would determine the availability of these systems, the smart systems. Mr. Miller says that the technology is there now to give you an early warning, say 30 second warning of a collision.

The technology is there and now we're waiting to actually implement it. Is that the marketplace we're waiting for to tell us there is a need when we know there is a need or am I mixing apples and oranges?

Mr. DOWIS. If I can just make a general statement. The Department is serving as a catalyst in this area. We, through the IVHS America group, are in fact not just sitting around and waiting for the market to adopt these innovations.

Bill or Charlie would you like to speak to this?

Mr. MILLER. Yes, I would.

Ms. Collins, what we had said earlier was that the basic technology is indeed there. We are currently engaged in research and development activity to take that basic technology, apply it to automobiles, test vehicles currently on the road, for example, and being developed and tested in California. It's a joint effort between the State of California, the automobile industry, and FHWA.

It's very simple technology. If you want to get right down to it, it's basically a radar system and a closing doppler effect, but yet needs to be further developed for widespread application. It is a very, very encouraging technology.

Ms. COLLINS. My next question is the Mag-Lev. What would be the start-up costs or the long-range costs of such a system in the United States?

Mr. DOWIS. The absolute cost of the system obviously depends on a whole host of issues such as the cost of land acquisition, such as the speed of technology development worldwide within the United States. There's no way, ma'am, that I can sit here and tell you what the long range cost is.

The Federal Railroad Administration—I'll ask Bob to speak to this in a couple of seconds—is right now looking at the economic feasibility of various routes. They are looking at the cash flow, if you will, of Mag-Lev on certain specific routes and they are also looking at the types of variables that I can't sit here and tell you right now. I think a year from now if you were to ask us that question, we would probably be in a better position to answer that. Would you like to add anything?

Mr. KRICK. In June of 1990, the FRA submitted to Congress at their direction a report addressing the preliminary economic and technical feasibility of Mag-Lev and in that we did identify certain potential markets and addressed the issue of what are best described as a lot of different people making a lot of different esti-

mates about what the cost of Mag-Lev would be, none of which have been validated.

So our current program is hoping by October of 1992 to have a definitive answer to that question, but people have been tossing around all kinds of numbers and I really don't like to give them any validity at this point until we finish our study.

Ms. COLLINS. So we're talking about 5 years, 10 years?

Mr. KRICK. If I could address that, there is currently German technology that is ready for commercialization and there is a couple of different places in the United States that are working to try to implement the German technology.

The closest one in terms of time is Orlando, Florida and they are talking about 1994 to 1995 for implementation date. The Anaheim to Las Vegas run right now it looks like it's towards the end of this decade.

If we were talking about a completely U.S.-based design system, yes, we're talking at least a 10 year time period.

Ms. COLLINS. Finally, if I still have time, Mr. Chairman, why don't we have a bullet train like Japan has? Right now it takes 3 to 4 hours to go to New York from D.C. by train. With a bullet train, we could do it in a hour or less.

Mr. DOWIS. If I could speak to that before I turn it over to Bob. We, in fact, do have in the United States a high speed rail system and it exists, as you point out, between Washington and New York. The Department of Transportation over the last several years has spent a large amount of money, somewhere in the $3 billion range, I believe, to improve that track.

Those trains currently now reach speeds in excess of 125 miles per hour on average. That is not that much slower than the Japanese bullet train itself, so for the details, I guess Bob would probably be better to answer that question.

Mr. KRICK. Yes, that's correct. There are some European technologies that are being considered in this country—namely the French TGV which currently is running at a speed of 187 miles a hour and the German ICE train which of the same order and speed. That's a little less developed at this point in time. They are being considered for locations in Texas, for example.

We have a different demography in this country relative to say what the Europeans have and relative to what the Japanese with their bullet trains. There is a much higher density traffic in Japan and that's what's driven them to go to high speed rail. We're rapidly getting to that point in this country and I think we're going to see a resurgence of interest in high speed rail.

Ms. COLLINS. Well, we were interested in it between Detroit and Chicago and I believe DOT is the one that will have to lead that because it goes through three states, Indiana, Illinois and Michigan. Are you going to pursue that or is that on the drawing board or is that just pie in the sky?

Mr. DOWIS. To answer them in reverse order, number one, it is not pie in the sky. I believe the Tri-State Compact, which is essentially what you're talking about, is an idea which continues to receive credence with the Department of Transportation. Secretary Skinner continues to mention it and give direction. Mr. Carmichael, who is the FRA Administrator, has the action on that and to

my knowledge, has continued to meet with officials from the three States as well as localities involved.

Bob, would you like to add anything?

Mr. KRICK. Mark, I think that's correct. At this point in time, the Administrator Carmichael is playing an advocacy role and a facilitator role to what extent we can. We don't have any funding to put into those programs but we are trying to encourage their implementation.

Ms. COLLINS. We need money.

Thank you, Mr. Chairman.

Mr. VALENTINE. Thank you.

The Chair recognizes the distinguished gentleman from Michigan, Mr. Henry.

Mr. HENRY. Thank you, Mr. Chairman.

Mr. Dowis, don't misunderstand what motivates my questions but after I've gone through a few here, please tell me if I'm on the wrong track and probably the wrong agency because my real issue before you is your perceived role definition, what it is you're trying to do. I think you know from my opening comment, I do appreciate what you've done in safety and I understand the importance of that issue. I understand how more intelligent highway systems, smart systems, relate to conservation and energy dependency et cetera.

My concern is this. If we get an intelligent vehicle highway system, I want to be sure they're driving on it in Fords and not Hondas, and meanwhile, when we're in our traffic jams, I want to be sure we're in a traffic jam in a Chevy and not a Toyota. In other words, what kind of industrial marriages are taking place?

We talk about Mag-Lev transportation. The Mag-Lev technology developed in the United States, ten years we put ourselves in park and so all your responses are, well, the French, the Germans. When we put in this subway system here in Washington, who manufactured the cars and did the engineering, the French, the Germans, even the Canadians. When we put in the ill-fated people mover in Detroit, where did the cars come from? They came from Canada. What in the world are we missing?

If, in fact, we can wed our technology to our manufacturing infrastructure in such a way, think of the question that Mr. Lewis raised in terms of for all the smart engineering of the highway system, if we could whip the problem of alcohol on the highway, you get a 50 percent reduction in fatality and injury. That would be the most dramatic.

What would happen if, in conjunction with you, we developed some kind of smart start system that American manufacturers were the first to hit and own the technology of it, own the licensing rights, every one of those vehicle owners would have a 50 percent cut across the board in commercial insurance rate.

If you take the life cycle average ownership of a car on the highway, it would be around 8 years, you could conservatively save $2500 to $3000 a year buying that car as opposed to another one and the market advantages would be so overwhelming that it would transform auto marketing and yet reach your safety goal.

My question I guess gets to that. The earlier question which was put to you was on Stevenson-Wydler. Stevenson- Wydler doesn't

talk just about collaboration and telling the world the steel manufacturers and the auto manufacturers, what you're doing, you have some suggestions; it's involved in technology transfer. How are you working with NSF's grants, let's say, in composite materials; how are you working with NIST and the coal neutron facility which is dealing with the development of composite materials, automobile engines which would be tremendous breakthroughs in weight and safety.

Can you give me the point behind Stevenson-Wydler was to transfer your theoretical possibilities into market realities that strengthen technological infrastructure in this country. So my question to you and the bottom line is, can you name me one commercial byproduct of all this with all our engineering centers—the one in North Carolina and the several in Michigan? What's come of it? What's it doing for us that it's giving us supremacy over than developing a system that maybe the Japanese are going to build the magnets for the Mag- Lev and the Germans and the French the cars?

Mr. Dowis. First and foremost, I do want to stress is, you well know, that DOT is a safety agency; that is our primary mission and we take that very seriously. The Secretary, in somewhat of a departure through the National Transportation Policy over the prior ten years has moved the Department more actively into promoting and strengthening the U.S. transportation industry and expertise. That has been one of the major themes and thrusts of the National Transportation Policy.

In relation to the Stevenson-Wydler question, I would point out that the Federal Highway Administration does a large amount of pavement research which finds its way into the private sector which increases the length or the use of the infrastructure. That is one example of where we have successfully transferred research that we have done in the department.

The Department takes technology transfer very seriously. Each of the modes themselves has a separate and discrete technology transfer program. The Turner Fairbanks Research Center is charged with transferring whether it's through documents, whether it's through shared research with the universities, the research that they have ongoing to both the universities and then ultimately to the private sector.

My Office of Research Policy and Technology Transfer is charged with coordinating over all the Department and the Department's tech transfer activities.

Another answer to your question will be addressed later on by Mr. Gilbert from Chairman Valentine's state which is the university transportation centers program. The Department currently, through UMTA and Federal Highway, provides $10 million worth of research funds to a consortium of 68 universities which in turn is matched by the private sector, by State and local agencies, so the intellectual ferment which I think you were referring to and the sitting down and brainstorming and saying where are we to be in 10 years, and how do we get there, is going on.

But, once again, back to my first point, safety is our primary motivation for our research programs.

Mr. HENRY. At that point, this same subcommittee deals with some FAA oversight and that's the safety agency when you're up there in the sky. You're the safety agency when you're down on the ground and not on your feet, unless you're crossing the street or unless you're on something that's paved.

Mr. DOWIS. Or riding a bike.

Mr. HENRY. I realize that's your chief mission and you've done it superbly well and on any comparative basis, we're still ahead of the curve, but when we get into aviation you see we have an FAA which deals with that—which also of course works through DOT on that—but also we have aeronautics components and research and technology in which we invest heavily with national industrial strategies which have given us world leadership.

Somehow when we got into surface transportation, we didn't even look at that component. We just assumed the problem was how do we make our cars safer, how do we make our highways safer as opposed to collaborating heavily in the dynamics of this with the industry. That's what I'm pushing for.

For example, Public Law 89-70 mandates that the Department of Transportation stimulate technological advances in transportation. Now that's rather comprehensive. To what extent have you fought within the agency or fought in the Congress and said we need more money to do these kinds of things? Have you ever tried to break into the trust fund for that kind of money or are we just talking about the stuff around the edges in terms of our university centers? I'm glad to hear they are getting private match out there.

Mr. DOWIS. The first comment I would make, sir, is we believe the IVHS America mechanism will be an excellent mechanism for bringing together the DOT with the industry and with all of the affected parties by IVHS.

Mr. HENRY. Will be or has been and is?

Mr. DOWIS. Just getting started, is already—to some extent, Dennis referenced the recent meeting out in Reston, more and more in the future, more and more and more.

Secondly, the Urban Mass Transportation Administration in point of fact, in the surface transportation reauthorization in the transit sector has gone forward with some of exactly what you're talking about. Larry, would you like to speak to your cooperative research program?

Mr. SCHULMAN. Yes. Thank you, Mark.

Mr. Henry, unfortunately some of the many examples that you went through in describing what is going on in technology in America had to do with the public transportation arena. I think that we have to acknowledge over the past decades we have fallen somewhat behind as a nation in providing technologies that can be used in public transportation in this country.

Under the Secretary's leadership, as part of the National Transportation Policy and as part of what is being proposed under the Reauthorization Act, we hope at the Urban Mass Transportation Administration, to reawaken our participation with the industry, with the technologies in this country dealing with the manufacturers and trying to develop technologies that can be used in public transportation.

They are very simplistic things in just the improvements in the basic bus industry. We're not looking for revolutionary improvements but we are looking for evolutionary improvements and working with the industry.

The rail car industry, as you pointed out, most of what's coming in or good parts of it, because we do have Buy America, are coming in from outside of this country. We only recently had a manufacturer reintroduce himself in America into the manufacture of rail cars.

We are very, very cognizant and concerned with exactly what it is you have outlined for us and hope to initiate a major technology, major relative size for UMTA, but a major component to deal just with that question, to deal with the industry and work with them to make this country competitive in the world markets in transportation technology.

Mr. HENRY. One final question, if I may. For example, Mr. Schulman, you mentioned bus technologies and one of the things we did is when we developed the first handicapping revisions—transportation has developed a technology that America manufacturers couldn't meet but other manufacturers across the Atlantic could, so we destroyed the manufacturing infrastructure of much of our own mass transit manufacturing capacity.

That's long ago and it's before I was here and probably before you were there, but someone screwed up royally in terms of implementing a policy of mass transit that in the plans that were utilized was counterproductive to the technological merging. I don't think that would happen today because everyone assumed, fine, they'll bounce back, the money is there. But we shot ourselves in the foot, so we all had to use the lifts.

One estimate places DOT R&D expenditures at approximately 1 percent of total DOT budget. If you compare that to when we berate private industry because it only has 2 and 3 percent that goes —it's up and down, the recession now, it's bounded around a little. Sometimes in recession actually the R&D goes up because the rest of the budget's down. We're bouncing somewhere between 2 and 4 percent on average in industrial R&D plowed in. You're about 1 percent.

Is there any federal department, any department in the federal government other than Congress and Judiciary, the purely administrative functions, or any operational department in government that spends less of its budget on R&D than the Department of Transportation?

Mr. DOWIS. I do not know. I'd be happy to provide that response for the record. If I could just make sort of a point around the edges.

The Department of Transportation has not traditionally taken a project by project approach to R&D. We tend to approach things from the point of view of what is the common goal, safety of the Department of Transportation, what is the common goal in a broader category like IVHS.

What we've done in the Department is set up an R&D management process which continues to move us in that direction. The issues like human factors, issues like economic competitiveness, the link between transportation and economic competitiveness are things that we are grappling with. In the past perhaps some

projects, a notable example was the turbo train the Federal Railroad Administration funded, those types of projects have been done but I guess the point I'm trying to make is we tend to look at broad goals for the agency and what is the best way across the transportation system to implement those rather than a specific project by project, National Science Foundation type of approach to R&D.

Mr. HENRY. No, I'm talking about the integration that Stevenson-Wydler calls for. I think that's already there. My question is, is it being done. Would the Department welcome a broader charge and more explicit charge in terms of taking your safety function and also wedding it to national industrial policy, for lack of a better term, in regard to this issue?

Mr. DOWIS. Mr. Henry, we believe that we have all the flexibility we need to get the job done.

Mr. HENRY. If you've got the flexibility, how come you haven't done more of this?

Mr. DOWIS. Once again, going back to my theme, we believe in the areas that have been the focus of the Department of Transportation, we have gotten the job done and we are now exploring transportation in the 21st century and answering questions through the R&D management process like what is the role of the human, what is the linkage between transportation and the environment, transportation and economic productivity?

We are beginning to move within our mandate under the direction of the National Transportation Policy towards a broader research agenda for the Department. We will continue to do that under Secretary Skinner's leadership.

Mr. HENRY. Is the Department getting, in fact, the participation of the manufacturing sector in setting your agenda and in working it through and in linking goals and objectives in the industrial base so they are flowing together?

Mr. DOWIS. The short answer to your question is yes. I believe NHTSA probably and Federal Highway are the leaders in the Department along with FAA in that area. Bill, do you want to speak to that?

Mr. LEASURE. Mr. Henry, I'd like to just pick up on your question with an example of I think a success story as to how NHTSA at least has helped foster U.S. technology and that is the issue of antilock brakes.

Antilock brakes was a difficult situation for this country in the mid-1970s when some of our regulations were struck down by the courts because the reliability of the systems was not there yet. The technology picked up in Europe in that interim time and started to come back into this country as usable technology.

We were interested in the technology, but we constructed a joint program with the industry and the purpose of the joint program was to prove the performance reliability of these systems. We insisted, however, on having U.S. participation before we took Initiative 1. By putting in place the $6 million program that has been underway for the last two years, we have been able to bring to the marketplace U.S. competitive systems which have proven themselves in the conduct of that experiment so far to be equal or superior to the European technology.

I think although we hear about the better organizations in Europe and Japan, I think the technology superiority here in the United States is still with us and I think all we have to do is to capitalize on that.

The purpose of the example is that I think that's the sort of experiments that you've heard spoken of by both Mark and the gentleman from Federal Highway that we're talking about in the future of IVHS. So I think these cooperative programs where the government and the industry works together, we all learn, we all share the burdens of the risk, both financially and legally, and I think that's probably the best promotion actually that we can do. We can take away some of the risks from the liability areas at least by proving that the systems are reliable and to assure that the systems are compatible with the limitations of the drivers.

Mr. HENRY. Mr. Chairman, if I may. I am pleasantly surprised to see the Lieutenant Governor of the great State of Michigan and her husband have just entered the room. I'd like to introduce the Honorable Connie Insfeld and her husband, John.

Thank you, Mr. Chairman.

Mr. VALENTINE. Welcome. We're glad to have you here.

Mr. HENRY. Mr. Chairman, I yield. Thank you very much.

Mr. VALENTINE. Thank you.

We appreciate the appearance of you gentlemen. The Chair will have several questions and perhaps other members which we will submit to you in writing. I will yield briefly to Mr. Lewis for a question which I believe he will ask you to respond to in writing.

Mr. LEWIS. Mr. Dowis, you speak of economic competitiveness and we'll have two more hearings in this area. The OTA and the Office of Technology Assessment says the Mass Transit Trust Fund has a surplus of over $6 billion which comes from the 1.5 cents of the gasoline tax. The Highway Trust Fund has as surplus of about $13 billion. This, of course, again comes from the gasoline tax.

Can you respond to us by next Monday for the remainder of the hearings, how much of this surplus money that you're going to be budgeting for long-term research and short-term research in the Department of Transportation?

Mr. DOWIS. We'd be pleased to do that, sir.

Mr. LEWIS. Thank you.

[The information follows:]

FY 91 (appropriated), FHWA: $103.4M; NHTSA: $21.4M; FRA: 20.6M; UMTA: $1.6M; RSPA: $2.3M. FY 92 (requested), FHWA: $102.6M; NHTSA: $23.7M; FRA: $25.8M; UMTA: $9.4M; RSPA: $3.0M.

Mr. VALENTINE. Thank you very much.

Mr. VALENTINE. The next witness is Dr. Gorman Gilbert, Director, Institute for Transportation Research & Education, University of North Carolina. Dr. Gilbert, if you would please summarize, your statement as submitted to us will appear in the record in toto. We welcome you here today, sir.

STATEMENT OF DR. GORMAN GILBERT, DIRECTOR, INSTITUTE FOR TRANSPORTATION RESEARCH & EDUCATION, UNIVERSITY OF NORTH CAROLINA

Dr. GILBERT. Thank you very much. I am pleased to be here, Mr. Chairman. Greetings from North Carolina.

I'll be very brief today. I'm pleased to be here today. I'm the Director of the Institute for Transportation Research and Education which was formed in 1978 by the University of North Carolina to coordinate all the research in transportation done by the 16 campuses of the University of North Carolina.

Our Institute is also the lead institute in a consortium of southeastern universities, including the University of Florida, the University of Tennessee, the University of Kentucky, Duke University, Vanderbilt University, and Georgia State University. This consortium has been awarded one of the center grants by the U.S. Department of Transportation, so we are the university transportation center for the southeastern part of the United States.

I believe that our experience at the Institute in conducting transportation research gives us some perspective on the types of research needs that we see for the North Carolina and for the southeast. I'd like to briefly comment on four of those that we believe to be very important. Some of these have already been discussed briefly and will be discussed more today, so I will try to be very brief in my comments on them.

One of these is infrastructure. We all know the infrastructure problems that we have in the United States and certainly in North Carolina and the southeast we share in infrastructure problems particularly in the decay of the quality of our highways and bridge programs.

We need continued research to learn how to inspect these facilities and how to take care of them. Currently before Congress is the reauthorization bill for the mass transportation program and the highway program. I personally urge you to do move quickly on these and to make sure as you do that, that there are adequate funds for research on the infrastructure questions that they pose.

The second research need is one you've heard a lot about already today, which is intelligent vehicle and highway systems. I believe it is important to view this from the perspective not only of the user but also from the transportation professional.

For decades, transportation professionals have combated traffic congestion largely by building new roadways. IVHS, however, gives us a whole new set of tools in dealing with highway congestion. There are four types of IVHS technologies — traffic management systems, driver information systems, commercial operations vehicles, and automatic vehicle control systems. Together, these four categories represent the application of sophisticated communications and control technologies to help traffic more efficiently with greater safety.

You've heard about the formation of IVHS America. I personally believe this is a very important and very interesting conglomeration of private and public interests to try to focus and concentrate IVHS research and development in the United States. Our university is a member of IVHS America and we expect and hope to play

an important part in helping to bring IVHS technology to from the drawing boards to the streets and roadways of North Carolina and the southeast.

We are particularly excited about a proposal from one of our constituent institutions—the University of North Carolina at Charlotte—to make Charlotte a demonstration test site for IVHS technology. The Federal Highway Administration and the North Carolina Department of Transportation have already provided some seed money to try to help develop this concept and we are excited about making it happen.

The third high priority research area is that of alternative fuels. I think that so much attention has been given to this topic that I really don't feel a need to expand on it here. It's sufficient to say, however, that despite the decades of discussion about alternative fuels, we stand today as dependent as ever on foreign fuel and on shortages and instabilities in the production of foreign petroleum.

I think it's time that we move quickly to test alternative fuels in meaningful, large scale, fleet conditions.

The final research area is really not a technological one but rather a management and institutional research need. During the 1980s there was much attention on trying to increase the role of the private sector in the provision of transportation services. More recently, there have been several examples of private companies planning and developing highway systems primarily in California and Washington, D.C.

However, the progress of increasing the private role in transportation has been slow. I think one of the reasons is that we have much yet to learn about how institutionally we can incorporate the private sector along with the public sector agencies.

This concludes my comments. I'd be happy to answer your questions.

[The prepared statement of Dr. Gilbert follows:]

The University of North Carolina
Institute for Transportation Research and Education

1100 Navaho Drive, Suite 201, Raleigh, NC 27609
P.O. Box 17489, Raleigh, NC 27619-7489
Telephone: (919) 878-8080
Fax: (919) 878-8129

TESTIMONY BEFORE U. S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON TECHNOLOGY AND COMPETIVENESS

by

Dr. Gorman Gilbert, Director
University of North Carolina
Institute for Transportation Research and Education
Raleigh, NC 27619

April 10, 1991

Mr. Chairman and Members of the Subcommittee:

I am very pleased to appear before you today on behalf of the Institute for Transportation Research and Education at the University of North Carolina. ITRE was formed in 1978 to coordinate transportation research and educational activities among the 16 campuses of the University of North Carolina. The Institute contracts with the U.S. Department of Transportation, the North Carolina Department of Transportation, and other public and private entities to conduct research on a variety of transportation issues. We also provide training courses primarily for personnel of the North Carolina Department of Transportation and local governments in the state.

Our annual budget, in excess of $4 million, is predominantly focused on highway and public transportation issues. The Institute is also the lead university in a southeastern consortium of universities that include the University of Florida, University of Tennessee, University of Kentucky, Duke University, Vanderbilt University, and Georgia State University. This consortium, known as the Southeastern Consortium of University Transportation Centers (SECUTC), is the U.S. Department of Transportation University Transportation Center for Region IV. We receive approximately $1 million in federal DOT research funds each year. These funds are spent for research projects among the universities in the SECUTC consortium.

I believe that our experience at ITRE in conducting transportation research and training activities gives us

a perspective on what the research needs are for our region in the coming years. Today I would like to share with you my thoughts and recommendations on the research needs that we see for North Carolina and the southeast. These research recommendations fall into four categories:

1. Infrastructure (maintenance and construction);
2. Intelligent Vehicle and Highway Systems (IVHS);
3. Alternative fuels; and
4. Privatization of transportation operations.

I would like to comment briefly on each one of these.

Much has been written about the growing and alarming infrastructure needs for the United States. In North Carolina and the southeast we share in these needs. As a rapidly growing region, we need highways and bridges, in particular. We also need money to rehabilitate and maintain those infrastructure facilities that are already in place. Given the extensive discussion of our infrastructure needs, there is no need for me to amplify on the facts that have been presented to you many times in the past. Rather, I simply want to underscore the need for Congress to act quickly to pass a reauthorization of the highway and public transportation programs, legislation that now is in the Congress.

In North Carolina we are particularly concerned that this legislation provide a fair mechanism for returning motor fuel tax dollars to the state of North Carolina for use in our highway and public transportation programs. We believe that in the past we have been a donor state in that we have received back per dollar of federal fuel tax collected less money in highway and public transportation funding than have other states. We hope that the legislation before you now will rectify this inequity and that Congress will move quickly to pass the surface transportation bill.

Intelligent Vehicle and Highway Systems, commonly known as IVHS, represent an important new research and development opportunity in the transportation sector. For several decades transportation professionals have combatted increasing traffic congestion by building new roads. These decades have shown us that we cannot construct highways as fast as we can fill them with cars. The use of IVHS, however, gives us a whole new set of tools to use in dealing with highway congestion and safety problems.

IVHS includes four categories of technology:

1. Traffic management;
2. Driver information;

3. Commercial vehicle operations; and
4. Automatic vehicle control.

Together, these four categories represent the application of sophisticated communications and control technologies to help traffic move more efficiently and with greater safety. IVHS is an exciting application of technology that holds promise for great benefits for the driving public, as well as for passengers on public transportation vehicles. The Japanese and Germans have already recognized this potential and have begun extensive research and development programs designed to bring IVHS technology to the market place quickly.

In the United States we have been somewhat slow in undertaking this research and development activity. Recently, however, the U. S. Department of Transportation has moved to try to catch up with our foreign competitors in the IVHS field. The surface transportation bill that is before Congress includes over $50 million for IVHS research and development. It is important that this money be appropriated and that research and development activities in the IVHS area move quickly in the United States. To ensure that our efforts in this important research area are efficient and productive, the U. S. Department of Transportation has joined many private companies, professional organizations, universities, and research facilities to form IVHS America, an organization designed to coordinate U. S. research in IVHS. IVHS America offers the promise of expediting IVHS progress by focusing research and development activities and by setting uniform standards for the technology used in IVHS.

Our university is a member of IVHS America, and we expect to play an important role in helping to bring IVHS technology from the drawing boards to the streets and highways of North Carolina and the southeast. We are particularly excited about a proposal from one of our constitutent campuses, the University of North Carolina at Charlotte, to make Charlotte a demonstration site for emerging IVHS technology. Charlotte is a growing, mid-sized vibrant city, which will provide an ideal test site for IVHS. The Federal Highway Administration and the North Carolina Department of Transportation have provided seed money to develop Charlotte as a demonstration site. We look forward to using Charlotte and the facilities of the University of North Carolina in cooperation with the North Carolina Department of Transportation to learn more about what IVHS technologies work and to share that information with the rest of the country.

The third high-priority research topic is that of alternative fuels. Again, so much attention has been

given to this topic that I feel little need to repeat those arguments here. It is sufficient to know that, despite decades of discussion of alternative fuels, we stand today as dependent as ever upon foreign petroleum and as vulnerable as ever to shortages and instabilities in the production of foreign petroleum. It is time that we move aggressively to learn more about which alternative fuels are truly alternatives to petroleum in the transportation sector. It is time that we moved quickly to test these alternative fuels in a variety of large-scale fleet conditions.

The final research area is a management and institutional research need, rather than a technological research need. During the 1980s there was much discussion about increasing the role of the private sector in the provision of public transportation services in the United States. More recently, there have been several examples of private companies planning and developing highway facilities, primarily in California and Washington, D.C. However, institutions are sometimes slow to change, and the progress of increasing private sector involvement in transportation operations has been slow. One of the reasons is that we have much yet to learn about how we can develop the most effective cooperative mechanisms between transportation agencies and private companies. We need to learn more about the benefits of such cooperation and how private companies can be brought in to the planning and operating activities without stifling the creativity that these private firms bring to the process. This research requires continued evaluation of public-private ventures in order to learn which ones work best and why.

Mr. VALENTINE. Thank you, Dr. Gilbert.

Regarding automobiles, could you tell us what research you consider to be most important in reducing the number of fatalities and injuries on the nation's highways?

Dr. GILBERT. I personally believe it's going to be the IVHS technology you've heard about before. I think it's important to note that in forming the IVHS America organization, one of the four major activities within IVHS America is safety and human factors.

As you indicated earlier in your questions this morning, there are a lot of very serious questions about the human factors aspects of IVHS America and I think it's important IVHS America has highlighted those to begin with. We frankly don't know the answers to those questions yet.

Mr. VALENTINE. Carelessness and inattention, that's one thing. Physical impairment induced by drugs or alcohol is a different thing. Whichever way we look, we have to face the proposition that as we go into these advanced sophisticated technologies, it requires more attention, does it not, and the problem with driving under the influence is going to be greatly magnified, isn't it?

Dr. GILBERT. I believe it will be.

Mr. VALENTINE. What can be done, in your opinion, Dr. Gilbert, in human factors engineering to enhance highway safety?

Dr. GILBERT. Mr. Valentine, I'm not really an expert in that area so I'd prefer to have someone who knows more about that to answer your question.

Mr. VALENTINE. Let me ask you if there's been any significant research on the question of driver inattention and how technology can be applied to that problem?

Dr. GILBERT. There certainly has been a lot. Again, I'm not on top of that. The Research Center at Chapel Hill, as you may know, has been a leader in providing research in that area.

Mr. VALENTINE. What would you consider to be the future for students taking college courses in transportation and do you consider the current enrollments sufficient to continue the work that has begun?

Dr. GILBERT. To answer your last question first, no, I do not consider the current enrollment sufficient. I don't think that we're getting either in numbers or quality the types of students that we need to solve these problems. I think it's important to note that the DOT University Transportation Center Program, of which we have one center in North Carolina, one of the goals of this program is to enhance the recruitment of the brightest and the best students to come into transportation.

I think we're beginning to see some progress from that program. I think we'll continue to see it over the years, but right now, we're not where we should be.

Mr. VALENTINE. Let me ask you one final question and then I will yield to the gentleman from Florida, Mr. Lewis.

When we talk about intelligent vehicles, are we talking about special equipment installed on that vehicle that's in the nature of some kind of radar oriented sort of thing that operates with respect to things in front of or either side of or behind that vehicle or are we talking also about that kind of thing and about equipment which is a part of the highway system?

Dr. GILBERT. We're really talking about both of those and other things as well. We're talking about systems that provide more information to the driver so the driver can make choices. For example, knowing beforehand when an instance occurs up the road so to speak to be able to take a detour and avoid that instance, to know about stoppages of a different sort, to know about traffic in general. So we're talking both about having sensors in the vehicle that would alert the driver to things going on around him or her. We're also talking about sensors in the road that would pick up that information and provide it to the vehicles.

Mr. VALENTINE. Like equipment around or near an overpass to warn a vehicle a mile from that point?

Dr. GILBERT. That's right.

Mr. VALENTINE. That the obstacle was there.

Dr. GILBERT. That would be one version of IVHS.

Mr. VALENTINE. I yield to Mr. Lewis.

Mr. LEWIS. Thank you, Mr. Chairman.

Dr. Gilbert, the fiscal 1992 budget contains funds for the university transportation centers. Are you familiar with the type of research that the centers conduct and what would be some of the strengths and weaknesses, in your judgment?

Dr. GILBERT. First of all, yes, I am generally familiar with them. I've been at the university, have come back from the private sector about 3 months ago, so I'm getting reimmersed in the university atmosphere.

There's been a wide variety of research. Each one of the ten centers has a theme associated with it. Our theme happens to be fairly broad and it's focused on the southeast. Some of the themes, such as the University of Michigan's center, is focused on heavy truck transportation issues, so it varies from across one center to the other.

I think within the centers, there's been a wide diversity in types of research and I think frankly that's one of the criticisms of the program so far. As the program has developed there has been more and more of a focusing that's occurred on the types of research. Certainly in our case, that's true and it will continue in the future.

Mr. LEWIS. I am concerned about the incompetitiveness we have with a number of countries and certainly with Japan. I had an interesting conversation with a gentleman last week. He asked me if I knew how many American automobiles were imported to Japan in 1990? I said oh, I'd take a rough guess say maybe about 10,000, 12,000. He told me it was 1500 and he had sufficient data to support this.

Is long-term research our keystone to meeting our competitive needs. In your opinion, what do we have to do in order to increase our competitiveness, not give away our technology and still hold the lead in technology?

Dr. GILBERT. I think as someone pointed out this morning, we need to increase the funding for research. I think particularly during the 1980s, we've lagged behind and we are beginning to catch up a little bit, but I think we have a long way to go yet. I think frankly, we're paying the price right now for not investing in research during the 1980s.

I think it's a question of getting our research funding back up to where it should be and doing a better job of managing it. That's why I think the University Transportation Center Program is very interesting because for many years, the universities responded to DOT's initiatives and research. They would list topics they were interested in having research conducted on and the universities would write proposals.

What the University Transportation Centers Program does is to turn that around. It says to the universities, you're supposed to be innovative and thinking about the future and where we ought to be going, you tell us what we ought to be doing research on.

This program has been in place for three years and it's taken a while for the universities to realize the game has changed a little bit. I personally think in a couple more years, we're going to see a lot more benefits of that program because universities will realize they can be more innovative and more forward thinking in the types of research they conduct.

Mr. LEWIS. One final question. You probably heard me ask Mr. Dowis the question of errant drivers, drunken drivers. What do you think the answer is and do you think that we in government has a responsibility to provide research and development into smart switches and ignition systems and automobiles to prevent drunken drivers from being able to operate a car?

Dr. GILBERT. I think we do have a role. I think there should be a public/private role. It should be joint research activity.

Mr. LEWIS. I'm happy to hear you say that. Thank you, Mr. Gilbert.

Thank you, Mr. Chairman.

Mr. VALENTINE. The Chair recognizes Mr. Henry?

Mr. HENRY. Thank you, Mr. Chairman.

Dr. Gilbert, first, let me say how pleased I am to have you here and of course you were at the Ann Arbor facility and Lansing and the Hope facility, and I know they have had a very good relationship with your facility in Chapel Hill.

Dr. GILBERT. That's right, we have.

Mr. HENRY. I know that you have kind of divided up the research turf and that's been part of this.

My concern continues along the same lines that I expressed to the Department of Transportation folks as well. To what extent do we get industry support for the centers from the automotive industry in particular? Has that been forthcoming, for example, in your budget, is the relationship close enough that the Automobile Manufacturers Association has expressed an interest in funding your research as well?

Dr. GILBERT. I really don't know that. In our case, in our particular center, the answer is no. Whether that's true in the case of the Michigan Center, I really cannot say.

Mr. LEWIS. Maybe we could have the Department, if they are still here, give us some data on those things because I think that would be one of the keys that we'd see in terms of what kind of relationship is there. If they are not putting money into it, then probably means they have not yet seen rightly or wrongly any linkage between their economic well- being and your research which is not to question the research whatever. Something is wrong then if

we don't have those kinds of linkages. Either you haven't reached out or they've been blind and haven't taken your hand or something else.

Are the manufacturing people from HUD which do the big rail vehicles and GM and Ford and Chrysler, and the electronics people, are they on your campus and working with you as visionaries or is it pretty much an academic exercise in abstraction?

Dr. GILBERT. Again, I can only really speak at our particular center. We have not gone to some of those firms to ask for matching dollars, for example. We've had other kinds of projects that have not involved them. That's not to say we shouldn't be doing that and I think we probably will be in the future. When I said earlier, we have not gotten that kind of support because we have asked and haven't received it, we haven't asked in our particular case.

I believe that some of the others centers have had more interaction with those groups and I really have to defer to them to answer those two questions.

Mr. LEWIS. Another issue of concern to the Chairman, and he's been very, very interested, as you know, in technology transfer and one of the leaders of the SEMATECH issue and that center is down in your area is one of the centers too, is it not, in the Research Triangle.

I would think if we're dealing with intelligent systems and highways, you're dealing with a lot of electronics that would interface with the auto industry. SEMATECH is very sophisticated research, you've got all the major electronics vendors. Are they involved in your project in seeing what role this might open up for them?

Dr. GILBERT. Well, they are going to be involved in the activity in Charlotte, yes. Charlotte people have talked with them a lot and it's quite clear there is going to be a lot of private sector involvement in that project. In that case, yes.

Mr. LEWIS. So you've got the relationship and the participation of the electronics folks. In that Charlotte project you have to obviously have the vehicle manufacturers too or not—no, I guess it's just a few vehicles, prototype vehicles that float around.

Dr. GILBERT. No, there's going to be a lot of vehicles floating around on that. I don't believe they have made any overtures yet to the motor vehicle manufacturers in that particular project.

Mr. LEWIS. How many vehicles would you anticipate being involved in this project, the whole Mecklenburg County area?

Dr. GILBERT. Thousands of them. I'm not sure what the number is going to be.

Mr. LEWIS. I would hope that you would just consider some of our early discussions as we look in terms of how we can seize commercial advantage in the technological transfer of this safety energy efficiency concern.

Dr. GILBERT. I hear you.

Mr. LEWIS. Thank you.

Mr. VALENTINE. Thank you, sir.

We have been joined by the distinguished lady from Maryland and I'll recognize Ms. Morella.

Ms. MORELLA. What a wonderful Chairman. Thank you, Mr. Chairman.

I've tried to pull together some of the comments that you've made Dr. Gilbert and Dr. Winston too. I understand something about smart highways and what was mentioned in terms of your concept of energy efficiency and safety.

In this whole discussion about transportation, I am concerned about what we do about urban thrombosis. By that I mean all these cars on the road, what are we doing to get them off the road? Are we also in the scheme of things—I know you were talking about technology. Are we also talking about planning of areas, land use planning as it goes along with it, are we also talking about technology for mass transit? How do we keep cars off the road or do we simply say we're going to come up with more energy efficient cars in a safer way and that's the answer?

I would just like to open it up to your comments on land use planning, either modes of transportation, maybe what can be done to foster more car pooling as well as mass transit. Would you like to comment on that?

Dr. GILBERT. Sure. I'll try to comment on several of those. In our particular case, we've done a lot of work trying to coordinate land use decisions and transportation decisions. In fact, some of the research done in our center in North Carolina has been focused on this. All of our transportation folks have said, we recognize that there are land use implications of our transportation improvements and vice versa.

We need to be able to make decisions about both transportation and land use simultaneously, taking the other one into consideration. We've had several projects, for example, that develop mathematical models that are used for local planners and policy decisionmakers in addressing those issues.

These are long term, very difficult kinds of issues, so we are taking a crack at those. I'm not sure we have the answer.

We are also very much aware that in our particular area which is really the central part of North Carolina, we have a very strongly urbanizing area, growth is occurring very quickly, traffic congestion is growing very quickly. We recognize just building roads is not the only answer. We need to put in place mass transportation facilities that will meet our needs today as well as in the future.

One of the things we're doing, for example, is looking at some railroad corridors, some rights-of-way to try to preserve so that some day when we need rail, we won't have to go back and pay an enormous cost and buy up land but we will have lands already preserved. So I think we are taking some steps to try to address those issues.

Ms. MORELLA. Some of those issues might be able to be addressed even faster than some of the catching up of technology with implementation.

I have another concern too that Americans just don't realize the whole problem with transportation and how it affects our energy policy, technology transfer and whatever. We look to others to come up with the instant solutions where we ourselves don't feel that we are part of the picture and I don't know that you address any of those as you look at the psychology I think of the public?

Dr. GILBERT. In our particular case, we have not done any studies on that, although the transportation academics in general have done a lot of studies on that.

Ms. MORELLA. Thank you very much.

Thank you, Mr. Chairman.

Mr. VALENTINE. Dr. Gilbert, we appreciate your sharing this information expertise with us and there might be some questions some members of the subcommittee would want to present to you in writing. We'd appreciate it if you would look at those and let us have the answers.

Thank you very, very much, sir.

D. GILBERT. Thank you.

Mr. VALENTINE. The next witness is Mr. Lester Lamm. Mr. Lamm is President of the Highway Users Federation and IVHS America. Welcome, sir. We'd appreciate it if you would condense your statement. Your prepared remarks will appear in the record as presented to us.

STATEMENT OF LESTER LAMM, PRESIDENT, HIGHWAY USERS FEDERATION AND IVHS AMERICA

Mr. LAMM. You've already heard this morning from government and the universities and I represent the third major cooperating interest in IVHS America and that is private industry.

Although the Intelligent Vehicle Society of America, of which I serve as President, is equally balanced between public sector and private sector, in my other function as President of the Highway Users Federation, our members are entirely private sector and the largest single group of members are the vehicle manufacturers.

The question to us, to the private sector, is not whether the U.S. has the technology or can use it; it's how can we best coordinate what's been going on for decades, implement that technology, and convert it into something marketable that can eventually get out into 190 million motor vehicles, 4 million miles of roads and streets to improve driving conditions, highway efficiency and highway safety for generations of Americans?

In particular, the relationship between government and especially the Federal Government and the private sector has often been adversarial rather than cooperative. So how can we change the whole nature of the interrelationship between these two major sectors of the economy and make things cooperative in the future?

In my prepared text, there is a lot of discussion about the Intelligent Vehicle Highway Society of America and in a few short months, I think we've made a remarkable amount of progress. We worked cooperatively with the Department of Transportation and with other government agencies to do that, and with the university sector.

I would say in closing though that what we've done so far is only a step in what I feel will be eventually perhaps the most significant impact on the transportation movement in the United States of anything that's been since 1956 when we undertook the construction of the interstate highway system.

In particular, I've worked myself since 1955 to improve road safety and road efficiency and I'm convinced that my generation of

transportation leaders can do more for the future generations if we make IVHS a reality than anything else that's in our potential right now.

What is it that Congress should do? I see three things in particular. First of all, the entire concept of intelligent vehicles and highways is a long-term process. We're talking about research that began perhaps 25 years ago and will continue well into the next century perhaps until the middle of the next century before the ultimate generation of IVHS is actually ready to be in place.

I think Congress needs to recognize the long-term concept and provide a steady stream of financing so that the government agencies and the cooperating private sector can count on a push, a leadership role by the Federal Government, particularly during these early critical years or perhaps decades.

I think specifically, the authorizing committees that are looking at surface transportation reauthorization this year should very definitely have a line item in the final product that deals with intelligent vehicles and highways, and then too, the appropriation committees in their annual look at DOT's budget, need to make sure that there's enough money devoted to intelligent vehicles and highways.

I point that out because the United States back in the 1960s was the world leader, the undisputed world leader in what is now IVHS technology. It was called a different term then, electronic route guidance systems. The only research project funded by the Federal Government in the late 1960s was cancelled by the appropriations committees because at that time they could not visualize an era when something like a computer would be in somebody's automobile.

I own a Buick, a 1989 Buick, and there are enough computer capabilities in my car that there are 27 separate functions that are computed onboard that weren't even visualized 20 to 25 years ago. So I think it's important for the appropriations committees to take the long-term view even though short-term budget concerns might be a real problem.

This committee, I would like to see give significant amount of your attention to intelligent vehicles and highway systems. Although you deal with technology across a number of factors and a number of different elements in the U.S. economy, I'm convinced there is more to be gained by benefits in surface transportation through IVHS than perhaps anything else in your own committee's purview.

I hope you'll have periodic oversight hearings on how IVHS is working. When you do and if you do, we'd certainly be very happy to continue cooperating through IVHS America.

Mr. Chairman, that completes my testimony. I'd be very happy to answer any questions you might have.

[The prepared statement of Mr. Lamm follows:]

STATEMENT OF

LESTER P. LAMM

PRESIDENT, HIGHWAY USERS FEDERATION

PRESIDENT, IVHS AMERICA

BEFORE THE U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

APRIL 10, 1991

Mr. Chairman and Members of the Subcommittee:

My name is Lester P. Lamm, a member of the Executive Committee of the Transportation Research Board. I am also the President of the Highway Users Federation and of IVHS AMERICA.

I have been asked by Thomas B. Deen, Executive Director of the Transportation Research Board, to testify today.

We appreciate the subcommittee's interest in surface transportation research, and welcome the chance to discuss the role that IVHS AMERICA will play in the development of Intelligent Vehicle Highway Systems throughout the nation.

The United States stands at the threshold of a national cooperative program which has the potential to greatly enhance levels of mobility and safety for present and future generations. As a complement to present transportation construction and improvement programs, the IVHS program will help provide global technolgical and organizational leadership for America and improve our international competitiveness while contributing to present and future social needs.

The Intelligent Vehicle-Highway System, or IVHS, is the next major public works/private sector cooperative activity as we enter the post Interstate system era. It will involve substantial benefits over a significant period of time. The program involves a large and complex system and is comprised of a number of closely linked and interdependent parts.

The IVHS program exhibits a significant level of cooperation between government at all levels and industry as represented by the motor vehicle, electronics, communications, computer, transportation services industries, and the intellectual community as represented by the universities of the nation. Just as happened in the earlier highway program and the space program (only two examples), this program will enrich the technical and intellectual resources of the nation.

There are measurable benefits in this program not just for users of the transportation systems but also for all of society. For example, improved mobility reduces fuel consumption which results in lower transportation costs and national economic benefits, as well as improved environmental quality.

Oversimplified, IVHS is a system comprised of vehicles and highways with an electronic interface between them collectively providing a more efficient, productive capability. IVHS, therefore, has no specifically defined physical identity or magic date in the future when everything changes overnight. It will be a continuous evolution from today's non-integrated highways and vehicles towards a completely integrated system. Each incremental improvement will provide more benefits to both operators and users of the system.

For example, early steps will provide travelers with better information so that they can make informed judgments regarding transportation mode and route choices. Next, drivers may be given aids to enable them to perform better, e.g. older drivers may be able to obtain night or peripheral vision enhancement. Traveler/driver information transfer will eventually give way to data transfer

needed for improved traffic management devices and systems. Later, streams of vehicles may be controlled in critical portions of the system network to permit greater overall flow. In certain high density situations, we may even see individual vehicles under advanced vehicle controls, thus greatly increasing flow on selected links of the IVHS system.

For purposes of definition and organization, the program is subdivided into four elements -- advanced traffic management systems, advanced traveler information systems, commercial vehicle operations (including transit, carpools, vanpools and other forms of travel -- both people and goods), and advanced vehicle control systems.

The question is no longer whether these advanced technologies will be available, but rather, how can we coordinate the many diversified activities needed for eventual application to our vehicles and highways. For the past two years, an informal group called Mobility 2000 had been meeting to discuss and coordinate the activities of government, including state and local transportation managers, industry, (especially those firms engaged in motor vehicle development), and those designing and manufacturing electronics, communications, computer equipment, and those providing transportation services, as well as the academic community. Congress has recognized that these IVHS-based improvements will have to be accomplished through a more formal and thoughtfully planned, coordinated national cooperative program. As part of its fiscal year 1991 transportation appropriations bill, Congress expressed its concern over the lack of such an IVHS coordinating structure in the United States. Today, I am happy to report that, thanks in part to funds appropriated by Congress for this purpose, IVHS AMERICA has become that coordinating mechanism. Much of the future success of IVHS depends on our ability to

coordinate the efforts of government bodies, industry and the academic community.

IVHS AMERICA was incorporated in August 1990, as a non-profit educational and scientific association, (IRS 501 (c) (3), to assure this coordination on a uniform, stable, and continuing basis. IVHS AMERICA currently has about 150 corporate members and approximately 75 individual members, and our membership list is growing daily.

The governing body of IVHS AMERICA is an Executive Committee equally balanced between public and private members. Much of the actual work of IVHS AMERICA is accomplished through a number of technical committees having representation from industry, all levels of government, universities, and even participation from the international community.

Among the several purposes of IVHS AMERICA is its role in serving as a chartered Federal Advisory Committee to the U.S. Department of Transportation, providing advice and recommendations to DOT on its IVHS program. IVHS AMERICA also assists in assuring that DOT's work is coordinated with similar IVHS activities being conducted outside the department. IVHS AMERICA also defines goals, objectives, and programs for the development of Intelligent Vehicle Highway Systems in America. Other priorities include:

a) fostering IVHS research and development; b) helping make decisions on IVHS development and use; c) addressing legal and institutional issues and ways to reduce them; d) identifying needed standards and arranging for their development and adoption; e) helping alleviate state/local jurisdictional problems in order to facilitate IVHS coordination across state and local boundaries; and f)

helping determine the architecture of an IVHS system, including divisions of responsibility of the public and private sectors.

IVHS AMERICA recently held its first annual meeting in Reston, Virginia. More than 500 participants attended plenary and committee sessions. A new technical committee was added for advanced public transportation systems to ensure full consideration of the wide spectrum of transit issues and opportunities to help allevate regional congestion problems.

A major work program for IVHS AMERICA was outlined at our annual meeting and approved by the IVHS AMERICA Executive Committee. We have given copies of this and other background materials to the subcommittee staff. One principal activity will be the development of an IVHS information clearinghouse which will provide information to all parties (IVHS AMERICA members, public officials, the media, etc.) who are critical to the successful implementation of Intelligent Vehicle Highway Systems. This clearinghouse will not replicate existing transportation-related clearinghouses, but will be a comprehensive source of IVHS-related information that will be vital in preventing duplication of effort and promoting a more integrated national research and development program. It is important that such an information source be in place from the earliest stages of development. For this reason, installation of an information clearinghouse is one of the primary objectives of IVHS America for 1991.

We are currently conducting Phase I of the clearinghouse, the requirements definition phase. We are generating a survey that will be sent to our members to obtain realistic information requirements. In parallel, we are visiting several other transporatation clearinghouses to determine if any lessons can be

learned from the more general libraries. We are also working closely with the Department of Transportation, to make sure that their information and retrieval needs are adequately addressed. The expected completion date of Phase I is July 1991. Phase II, system configuration, will be completed in August 1991. Phase III, system installation & orientation, is planned for completion in the first quarter of calendar 1992. In the interim, we are assembling a manual system to aid interested parties in obtaining required IVHS information.

A second major project emanating from the 1991 work program is the development of a coordinated strategic plan for IVHS. This plan, when completed, will serve as the framework for guiding the activities of the technical committees as they carry out their work. The plan will outline the vision for a national IVHS program and provide a planned approach for achieving the vision. The plan is being designed to include goals, objectives and milestones with a specified course of action for their achievement. The plan will also assess the technical and non-technical constraints facing the program, with suggested ways of surmounting them. Appropriate IVHS Technical Committees will be involved in the development of the plan. The final strategic plan will represent a coordinated effort which will have maximum acceptance within the IVHS community. The planning process will result in a workable document in time to assist the DOT agencies in preparing their Fiscal Year '93 technical programs.

In the short period of several months, IVHS AMERICA has made considerable progress toward becoming an established Federal Advisory Committee, as well as becoming the coordinating point for industry, academia and government on IVHS matters. This national public-private coordinating organization is now in place and dedicated to guiding the complex research, development, and deployment activities in the high priority IVHS program.

Mr. Chairman, we are most excited about the unlimited potential for better surface transportation for future generations of Americans underlying the concept of Intelligent Vehicles and Highways. I myself have worked since 1955 to improve efficiency and safety on U.S. Highways. I'm concerned that the most significant gains my generation of transportation managers will ever make lie ahead, if we can realize the full potential of IVHS.

Thank you, Mr. Chairman. I would be pleased to answer any questions you may have about our program.

Mr. VALENTINE. Thank you very much, Mr. Lamm.

Can you tell us what demonstrations have been made with this technology and what the results are?

Mr. LAMM. In my testimony, we've highlighted several and also in the DOT testimony, they specifically mentioned projects in California and Florida which are well underway. In addition, there are planning groups in Minnesota, in Illinois, in Michigan, in Virginia, in North Carolina and other places around the country. The entire northeast quadrant of States—New England, New York, New Jersey, and Pennsylvania—are trying to put together an overall demonstration program for that region of the country.

So there is an awful lot to talk about. I'd be very happy to expand on these comments for the record.

Mr. VALENTINE. You are familiar, I am sure, with the work done by Dr. Gilbert and his people at the Institute for Transportation Research and Education?

Mr. LAMM. Yes, sir, I am.

Mr. VALENTINE. What is your judgment with respect to the cooperation between the various elements out there in the country addressing this problem, for example, what Dr. Gilbert testified to with respect to what they intend to attempt in Mecklenburg County, North Carolina?

Mr. LAMM. I would probably not be involved on rating individual demonstration projects. I'm convinced we're going to need dozens, perhaps even up into the range of 100 or so as the years go by.

IVHS America does not want to get into a position of perhaps trying to establish some criteria among competing demonstration projects from around the country, so I wouldn't want to comment specifically on that one other than to say I know a number of the people that are involved in the university complex in North Carolina. There's an awful lot of talent there that deals with a number of different elements of this problem, particularly the human factors issue.

Some of your earlier questions to the government witnesses got into human factors and I know in Chapel Hill, there is a very fine facility with excellent leadership in the human factors area. So my hope is that each of the demonstration projects will take the characteristics of that region or the universities in that region or the particular travel characteristics of the driving public in that region and make the demonstration project highlight factors that are significant in that area so that we don't have a complete duplication and we have 10 or 15 people in different parts of the country all trying to do the same thing.

I would like to see the North Carolina project and in fact, all of the projects seize on the strengths in that region and work on problems that are particularly significant to the citizens of North Carolina.

Mr. VALENTINE. It has come to our attention that officials in Honolulu expect to receive up to five proposals in May of this year for designing, constructing and operating a driverless rapid transit system. It would appear therefore that such systems are fully developed. What is your opinion with respect to the state of this art?

Mr. LAMM. Well, there was some discussion earlier about the people mover project in Michigan and people mover projects in

general are transit vehicles which operate without drivers, so the technology very definitely is in place right now. Whether or not the Honolulu project would represent the type of demonstration project that would answer questions that haven't been answered before, I can't evaluate. Perhaps that question is better addressed to the urban mass transit people in DOT.

Mr. VALENTINE. In your opinion, finally, for me, what additional research and development is needed in connection with the intelligent vehicle development and what could, in your opinion, be most beneficial, if that's an adequate way to put it, to assure safety or improve the economics of this endeavor?

Mr. LAMM. As far as how much funding and where it should come from, I'm very happy with the progression of research funding that's in the DOT budget over the last few years. In 1989, there was roughly $4 million plus devoted to intelligent vehicle and highway research. This year there will be $20 million; next year, there will be somewhere between $20 and $50 million.

I think in a very short period of years, the groups that I represent that have banded together under IVHS America would be able to handle $100 million a year program for research in IVHS. Once that research level begins, it's important to have it continue so that again people that are involved in answering long-term questions, can count on a guaranteed level of financing for the out years.

My personal belief is that we ought to begin a program that consciously adopts maybe a middle range goal of a 10-year concept plan funded at say the better part of $100 million a year over that 10-year program and then as we approach the mid-point and the end of that 10 year period, let's reevaluate. Let's see what we've accomplished with that money, has it been productively used, is there a reason to increase the program in the following succession of years and so forth.

Mr. VALENTINE. Thank you, sir.

The Chair recognizes again the distinguished gentleman from Michigan, Mr. Henry, who continues to make such outstanding contributions to the work of this subcommittee.

Mr. HENRY. Mr. Lamm, with your 150 corporate members, your 75 individual members, are you really talking about people who attend an annual convention to kind of get an update as to what DOT is doing and maybe would like to be vendors somewhere down the line or are these people who really have an active an coherent interest in working with DOT constructively in pursuit of a vision?

Mr. LAMM. I think in particular the private sector organizations that are involved in IVHS America do so with a degree of enlightened self interest. They see a potential market someplace down the line and that's the American way. That should happen that way.

On the other hand, the annual meeting was more than a group of people sitting on their chairs listening to other speakers throughout a three-and-a-half day period. We had meetings of every single technical and every single administrative committee that has been put together under IVHS America. Your comments with other witnesses highlighted standards and that's probably, other than the long-term planning committee, maybe the most sig-

nificant technical committee in its activity that we'll have in the next several years.

That committee is very active. It will meet again in June and has a tremendous amount of volunteer support. In fact, if there's anything, there are more people clamoring to get involved in the committees and get involved in the early planning than any of us thought was possible.

So I am convinced that we didn't have 500 people curious, we had 500 people willing to help and asking how they can help.

Mr. HENRY. When you talk about enlightened self- interest, there is nothing wrong with that. I'm commending it. I'm glad to see there's that kind of interest out there. Obviously I can see the electronics side of it, I can see the construction side, it may even change the way you pour concrete and those kinds of things.

Mr. LAMM. I think all of these will come to pass and all of those interests are involved at the early stages in IVHS America.

Mr. HENRY. Obviously they are there because they see commercial transfer and profit.

Mr. LAMM. Right.

Mr. HENRY. Does the Department see that or is the Department just looking at in terms of here's a way of getting fuel efficiency and safety, which I'm not diminishing, but I'm still hassling that, so I'm giving you a chance.

Mr. LAMM. The nice thing about the IVHS concept is that it advances a number of public goals all at the same time. I'm convinced that there will be profit to be made by industry not only in America but probably in other industrialized countries as well.

In addition to that, while we improve the efficiency of highway travel and improve safety, we have immediate benefits in the order of tremendous reductions in traffic congestion, speeding productivity of the surface transportation systems so that goods can get where they are bound faster and employees get to work be kept productive from the first hour and so forth, and also safety and environmental issues. If the vehicles are not idling in traffic, they are not putting out as many emissions as they do today.

So I think we can make significant advances in all of these public policy areas at the same time by a judicious investment in IVHS.

Mr. HENRY. And they can work together. They complement each other, if they are brought together.

Mr. LAMM. In contrast to many other solutions to transportation problems, some solutions directly conflict with other goals. You might improve traffic by a device that ends up decreasing air quality. The nice thing about IVHS is their potential benefits for everyone.

Mr. HENRY. Obviously the whole bias I've brought to my questioning today has been kind of industrial concern for the industrial infrastructure. You've called for basically a billion dollar program of accelerated research and getting to the point which would take us to the point of potential implementation.

Would it make as much sense as well to really force this issue in terms of say composite materials research as it would affect the automobile industry? After all you could have a car that is lighter but is stronger, so you get fuel efficiency and safety.

Mr. LAMM. I heard your earlier questioning of witnesses and there is a lot that we don't know yet about where we might eventually wind up in intelligent vehicles or in intelligent highway systems sometime in the future.

We can see that a lot of the goals are going to be fuel efficiency goals, there are going to be environmental goals, there are going to be safety goals, and all of those have a direct interplay between the materials that are used in the automobile and on the highway.

For instance, right now, people are concerned about reducing the weight of vehicles so much that you bring in safety penalty to the people who drive the new vehicles. If some composite vehicle can be developed and put in at an economic price that advances both safety and fuel efficiency, that question or that conflict disappears.

So perhaps the research that's going on in other phases of what the motor vehicle industry is doing, for instance, the motor vehicle members of IVHS America and the entire American big three are members, are also engaged in research with the American Petroleum Institute members on alternate fuels.

To the extent that research is successful, maybe we have a totally different national picture as far as the percentage of not clean air that results from motor vehicles by the time we come into the 21st century. That may change the ground rules that we are working at as far as what drives our priorities in IVHS.

I think all of these issues need to be taken together. Whether or not the group of organizations that are tied together under IVHS America have the new building materials or the specific alternate fuels as part of our purview, I think what we are doing is trying to make the communications system between vehicles on the road and the road itself be a help for moving vehicles through urban areas for preventing accidents in rural areas and so forth.

Mr. HENRY. I was. I was getting away from the intelligent highway system but I'm just trying to bang away again at this industrial policy issue. If you can get those composite materials to get you the fuel efficiency and the safety factor, we have experimental silicate engines. The reason we just don't know why some of them run for 200,000 miles and some run for 10 miles and break.

If we get that avenue, you'd have such a marked breakthrough in terms of cost, you'd take 300, 400, 500 pounds out of the weight of a car, when it's not running well, you don't bother tuning it, you junk it, grind it up in sand and throw it in the backyard, then you put in a new engine the way you fix a television today as opposed to the way you fixed one 20 years ago.

There's a lot there and what I'm really trying to do is get these components together and with the Department in a comprehensive thing so what's going on in that materials research at Ann Arbor and what's going on in the highways research in Chapel Hill, and what's going on in some of the other alternatives, comes together with an industrial policy, to say this is going to be ours and we're going to get it back again.

Mr. LAMM. It makes a great deal of sense and I think what we do in IVHS America can help because where the big three are members of IVHS America, it's really their research staffs who are members. Where SAE, the Society of Automotive Engineers, is a member, perhaps their particular committee is dealing with IVHS

but they are also the same people that are working within the automotive industry on the alternate materials.

Mr. HENRY. Thank you very much.

Mr. VALENTINE. Thank you.

The Chair recognizes the lady from Maryland, Ms. Morella.

Ms. MORELLA. Thank you, Mr. Chairman.

Mr. Lamm, you have like 500 people who showed up for the plenary session you had at the convention. Does this mean that you have approximately 500 members, or what's your membership like?

Mr. LAMM. Our membership right now, and it increased quite a bit during the annual meeting, is over 150 corporate or industrial members or national association members. The Automobile Association, for instance, they in turn represent 30 million drivers so there's a much wider group of people we can get at than the number 150 looks like.

In addition to that, probably there will eventually be 30 or so of the country's major universities. They will probably be the top 30 industrialized States who belong, their departments of transportation—Maryland, Michigan, and North Carolina are early member and I expect many others to join.

So I look for the early membership to keep growing but the indication of 500 is not by any means the limit of IVHS membership. There were probably, for instance, 15 people from the big three automotive industry among that 500. Well, you wouldn't expect to have 500 separate classes of members from that group.

Ms. MORELLA. I know that you work with government very closely, DOT and probably DOE obviously, are they considered members too?

Mr. LAMM. Yes. In particular, the Department of Transportation was an early cooperator. They have chartered IVHS America specifically to advise them on IVHS issues. In addition, we have met recently with the Commerce Department and some of your earlier questioning dealt with international competitiveness of American industry. That's really the concern of the Commerce Department.

The people we met with were very excited about the early progress of IVHS America. In fact, they commented that if other American industries had done the same thing to meld their activities with government and universities at such an early stage, perhaps we would not have lost high definition television technology at the stage we did and so forth.

So there will be representation. We've talked with the Energy Department, we've talked with several other major departments of the Federal Government. We know there is going to be a lot more interest than specifically DOT as this program gets underway.

There is a tremendous amount of interest by some State governments. Perhaps the only gap we have now in the public sector is at the local level, the government because most of the road system in this country is actually managed by local governments. If something is going to work across the board in 4 million miles, you can't have only the States working with you, you have to have the major cities who manage the road system as well.

Ms. MORELLA. The members pay dues?

Mr. LAMM. There is a sliding scale. I believe our staff has given the committee copies of our little brochure which does talk about

the membership rate. It's a sliding scale. The heaviest contribution comes from the largest industry; the smallest contribution comes from the smallest public sector group.

Ms. MORELLA. I notice also you have some projects lined up. One is your clearinghouse and you have different phases of that and it seems like you're moving pretty fast. The first phase, as I recollect from your testimony will be July?

Mr. LAMM. Yes, that's right.

Ms. MORELLA. And then August. Is that going along on course?

Mr. LAMM. It is starting out very well. We have a staff person assigned full time to get the clearinghouse off the road. This is going to be one of the major contributions that the organization can make because there has been a lot of work going in both in the research elements of the industrial representatives that we have, plus all of these potentially unconnected demonstration projects from coast to coast.

I think one of the significant roles of IVHS America, and one which DOT has specifically asked us to do, would be to make sure that the entire industrialized world knows what's going on in the United States.

Ms. MORELLA. Which is going to help with technology transfer too. Then you go into another project which is the strategic plan which I guess you're looking to in 1992, is that correct?

Mr. LAMM. Yes. What we're doing there, Ms. Morella, is to try and put dimensions on the intelligent vehicle highway system as we know it today. I talked about wanting to have a commitment on the order of 10 years in advance by Congress and the Executive Branch that they are willing to undertake a long-term research program.

I think in return Congress and the Executive Branch ought to know what people are going to feel will happen during that 10 year period, what will we get back for that billion dollars or so of investment. That's the concept of the strategic plan, to look ahead and put dimensions on what otherwise might seem like a far off into the future process that could be equated to Star Wars. It's nothing further from the truth than that because the intelligent vehicle and highway technology is here now.

The first time we bought a motor vehicle that had cruise control, we embarked on intelligent vehicles. The first time government tied two consecutive traffic signals together, we embarked on intelligent highways. We're here; we just need to advance what we're doing.

Ms. MORELLA. Thank you. I'm pleased that you're doing this and I hope that you keep us posted as you progress chronologically with your goals.

Thank you, Mr. Chairman.

Mr. VALENTINE. Thank you very much, Mr. Lamm.

Mr. VALENTINE. We come now to the last witness, certainly not least, Mr. Clifford Winston, who is a Senior Fellow with the Brookings Institute. We would appreciate it if you would, as I've asked the other witnesses, summarize and your prepared statement will appear in the record as presented to us. Welcome.

STATEMENT OF CLIFFORD WINSTON, SENIOR FELLOW, BROOKINGS INSTITUTE

Mr. WINSTON. I'm an economist with Brookings, I'm not a technologist. Let me quickly summarize what I was asked to do and weave in some overall comments about what's being said at this hearing.

I was asked actually to comment on economic issues, optimal payment life, the limits of expanded highway capacity or expanding highway capacity, congestion pricing and technology which is used to try to implement congestion pricing AVI. On top of that, I was asked to at least comment on the smart cars/smart streets technology, high speed rail, Mag-Lev and various trams.

It just happens I've written an article that deals with these questions and that's what I'm submitting as my testimony. I'll just quickly summarize the basic points there.

Let me make two essential points as the thrust of my testimony. I don't know whether any of this technology that's being mentioned is going to be socially desirable or not. I am utterly convinced that at this stage you are not in a position to judge whether any of this is socially desirable or not for the simple reason you cannot tell unless you know how things would look if you are making the most efficient use of your current infrastructure.

If your current infrastructure is not being efficiently used, then you don't really know what would happen if you introduce a new technology. It may very well be that some of these technologies are simply not needed if we make better use of our infrastructure.

So before going ahead funding any of these things, I would move very, very judiciously in looking at how our current infrastructure is being used in an efficient way.

Secondly, to the extent one does go forward with this technology, it should be weaved in with making efficient use of what we have now, so I don't think you can think independently of technological advances with making current efficient use of our infrastructure.

I may give you an extreme example in infrastructure that sort of gives you an idea about this. Consider the water resources problem in California. One "technological solution" has been to build a pipeline from Alaska to California. There, numbers at least have been bandied about of what the cost of that would be—at least $60 billion, probably closer to $100 billion.

No one could be serious about doing that given how water is priced and invested in. We know how gross the inefficiencies are with water resources and it's not clear that we would actually need to build a $100 billion pipeline from Alaska to California if we were making efficient use of water resources in California. That's an extreme case of where technology needs to dovetail in a sensible, efficient way with efficient pricing, investment mechanism and infrastructure.

Let me now summarize my points here about how to think about efficient pricing and investment for infrastructure. The idea really is to think of an industrial policy, that's what has been called for here and that's what I'm really offering, as an efficient package to improve performance on the highways and reduce budgetary con-

cerns. The idea is really not to spend more money at this point, it's to spend it efficiently.

The first part of this plan is congestion pricing and that really deals with the limits of highway capacity. Let me give you an example. If you want to expand highway capacity, the natural thing is you want to build more lanes, so you expand say a congested road from two lanes to four lanes. What's going to happen? People who previously avoided this road and used it at either different times of day or used different modes or took different routes, now all of a sudden find this road efficient to use and they'll go ahead and switch to it.

In the long run, the road will fill up again, so expanding the capacity doesn't really do any good. In the words of a popular movie, if you build it, they will come, from "Field of Dreams." That's the problem with highways.

You cannot solve that problem unless you have a pricing mechanism that discourages peak travel. That is the idea of setting congestion prices and that's being looked at.

What have been the advantages and concerns about congestion pricing? One advantage, it can cut the transit deficit. You will have people switching over to public transit, you can increase ridership, you can increase service. There you're now hitting an important deficit and promoting public transit.

Secondly, it can help with industrial competitiveness because you are now smoothing out traffic flow. Trucks which are an integral part of the freight system will now be able to work their operations more efficiently with shippers with just in time inventory. If they are stuck in traffic, they are not going to be able to do that.

Moreover, if you then go to sort of Draconian policies banning trucks in the downtown area to deal with congestion, you're going to slow down production efficiency. Congestion pricing will now give you an incentive not to do these things.

The problems with congestion pricing are implementation. We now have the AVI system to do that. That's exactly where technology dovetails into an efficient policy, using it to actually implement things you know will promote efficiency.

There's been privacy concerns with congestion pricing. That can be simply overcome by using a smart card like we have on the Metro. People do not have to know where you are, you can just buy highway time and use it all.

Income distribution concerns, it will only help the rich is the argument. That's simply not true. One can have explicit redistribution packages where you promote public transit use, you can lower property taxes, so on and so forth.

In Sweden, they sold congestion pricing on putting in an explicit redistribution policy. It can be done.

Then, experimentation. Throughout the world we've been having planned and actual experiments with congestion pricing and in California they are also having very serious consideration of it.

The second part of my program, truck pricing. We do not want to use gasoline prices to tax trucks. That has nothing to do with the damage trucks do to the road. Truck damage is caused by axle weight. You should replace the fuel taxes and put in a tax called an axle weight tax that gives the trucks incentives to use more

axles. They'll do less damage to the roads. It's a more efficient policy.

In the State of Oregon, they are actually now implementing this way of pricing trucks. You have axle weight prices for the trucks, congestion pricing for the cars, people now who either put limits on highway capacity or damage the roads are now asked to pay for what they do. You get efficiency in terms of lower maintenance expenses on the road, better travel times, and now you start cutting on highway expenditures.

Finally, you want to complement the axle weight taxing with an efficient investment in the roads themselves. You'll do less damage from trucks if you have thicker roads than there are now. That too will reduce maintenance expenses and I'm not calling for a large increase in spending.

You put the package together, congestion pricing of the cars, it's not going to cost you anything, very small; axle weight pricing for the trucks; optimal investment in terms of thickening the roads. You wind up roughly with an annual benefit of about $15 billion without spending that much money in terms of annual expenses.

This is the kind of package that now we can implement with technology and you think about these other technological advantages to do that, you can immediately go to solving problems. You won't have to be spending much on budgetary concerns and you'll get an immediate payoff.

Thank you.

[The prepared statement of Mr. Winston follows:]

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Efficient Transportation Infrastructure Policy

Clifford Winston

Spending public funds to revitalize America's worn and congested roads and runways ranks high on nearly everyone's list of ways for government to raise the nation's productivity. The Governors' Task Force calls for outlays of $1 trillion to $3 trillion over the next 20 years—well above current capital spending—to build more roads and airports. The Joint Economic Committee received a letter signed by more than 300 economists and heard testimony from Alan Blinder and James Tobin, among others, urging an immediate increase in public investment in physical infrastructure.

However, the consensus that public investment must be increased breaks down when it comes to how to raise the money. Some argue the federal government should raise taxes or user fees; Transportation Secretary Samuel Skinner has called on the nation's governors to raise state gasoline taxes. But gasoline tax increases are hard to get through state legislatures, and the federal government is reluctant to spend money on infrastructure because of the deficit.

This paper offers a different perspective on paying for and investing in the transportation infrastructure. The following example illustrates the need to move away from the current national mind set. Pick any pothole-laden, congested two-lane road in an urban area. Suppose public funds are used to widen the road to four lanes and to repave it. Benefits will immediately flow from this investment in the form of lower travel time and less vehicle damage. But many travelers who previously avoided the road during peak travel periods will now find the road attractive and want to use it. The improvements will also induce

■ *Clifford Winston is a Senior Fellow at The Brookings Institution, Washington, D.C.*

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long-lived land-use and vehicle purchase decisions. Before long the road may again fill to capacity and steadily deteriorate. Generalizing from this example, the trillion dollars spent over the next 20 years might result in expanded transportation capacity that eventually faces the same problems as before. This is an illustration of Downs's (1962) law: On urban commuter expressways, peak-hour traffic congestion rises to meet maximum capacity, because commuters shift from less preferred modes and times of day.

This cycle can be broken only if infrastructure is priced and invested in more efficiently. If the pothole-laden road is kept to two lanes when it is repaved but vehicles are required to pay efficient tolls based on congestion and pavement wear, then the road's capacity is far less likely to be exceeded during peak periods and its pavement will remain in good condition. Making efficient use of current transportation capacity will reduce the need for massive public investment in airports and roads and will prevent the recurrence of infrastructure problems.

Surprisingly, the belief of most economists that public infrastructure spending should be substantially increased is not based on efficient pricing and investment principles. Instead, it appears to be based on either personal observations or on a suspicion that because uncongested infrastructure is a public good, society has tended to invest too little in it. Both perspectives have diverted many economists and policymakers from realizing there are surprisingly large but plausible benefits from *efficient* infrastructure pricing and investment.

These benefits arise because airports and roads are characterized by pricing systems that do not reflect economic costs and by poor design decisions that have resulted in higher costs of use. If road and airport systems are priced and invested in efficiently, then the long-run requisite increases in investment are quite modest, the systems would be roughly self-financing in places where some congestion is optimal, and the federal budget deficit is reduced. Efficient infrastructure policy can also complement the beneficial effects that deregulation of the transportation industries has had on competition and firms' operations, and help to address the primary sources of current discontent with deregulation.

The Theory of Efficient Infrastructure Policy

Transportation infrastructure provides *capacity*, in the form of traffic lanes and runways, for highway and air trips, as well as *durability*, in the form of thick pavement, to facilitate trips in heavy motor vehicles and large aircraft. Users of the infrastructure impose costs on themselves and others by contributing to congestion, which increases travel time, and by wearing out the infrastructure, which necessitates maintenance expenditures to repair pavement and vehicles.

Efficient infrastructure policy maximizes the difference between social benefits and the costs of use, including the costs that users impose on others, by specifying pricing guidelines to regulate demand and investment guidelines to specify design. (Winston (1985) presents a mathematical derivation of these guidelines.)

Although the literature on optimal pricing and investment has a long and distinguished history that dates back to the writings of Pigou and Knight among others (see Winston (1985) for a survey), Mohring and Harwitz (1962) were the first to determine optimal pricing and investment policies in a rigorous long-run framework. Although recent work has extended their model to account for demand uncertainty, lumpy investment and so on, their basic insights remain intact. The efficient marginal cost pricing rule recognizes that when infrastructure users make travel decisions, they will ignore their contributions to congestion and infrastructure wear. As a result, the social costs of a trip will exceed private costs, and the infrastructure authority must therefore set congestion tolls and infrastructure wear charges to close this gap. The efficient investment rule calls for capacity and durability to be produced to the point where the marginal benefit from increasing investment in each dimension equals its marginal cost. The pricing and investment rules jointly constitute an efficient long-run policy, in which a user's full marginal cost is determined at the optimal level of capacity and durability.

Mohring and Harwitz also showed that the financial viability of a public infrastructure facility under optimal pricing and investment depends upon its cost function. If capacity and durability costs are jointly characterized by constant returns to scale, then the facility's revenue from marginal cost pricing will fully cover its capital and operating costs. If costs are characterized by increasing returns to scale, then marginal cost pricing will not cover costs; conversely, if costs are characterized by decreasing returns to scale, marginal cost pricing will provide excess revenue. The analysis that follows discusses the effects of implementing optimal pricing and investment guidelines.

Efficient Highway Pricing and Investment

The United States has nearly four million miles of roads, but roughly half of the nonlocal roads are currently in fair or poor condition, and traffic during commuter rush-hours approaches capacity on one-half of the urban interstates and one-third of the other main arterial highways (Small, Winston, and Evans, 1989). Efficient highway pricing and investment could dramatically improve the condition and performance of our roads, while requiring only a small increase in capital spending.

Historically, gasoline taxes have been used to charge vehicles for their use of the roads and to finance expenditures. The gasoline tax was a reasonable

way to raise revenue as long as roads were uncongested and in good condition. But fuel tax receipts fluctuate with economic conditions and fuel prices, and recent shortfalls in gas tax revenues have made it increasingly necessary to supplement the gas tax with state and local revenues.[1] These periodic shortfalls and continual uncertainty are one reason to move away from the fuel tax as a source of highway revenue. A more important reason is that the fuel tax does not reflect the pavement damage and congestion caused by vehicles.

Pavement Wear Charges

Pavements become worn as vehicles pass over them and eventually require resurfacing. Pavement damage itself depends on *vehicle weight per axle*, not total vehicle weight. The damage caused by an axle is defined in terms of the number of "equivalent standard axle loads" (esals) causing the same damage; the standard is a single axle of 18,000 pounds. Small and Winston (1988) report that this damaging power rises exponentially to the third power with its load. (This differs from the conventional belief that the damaging power rises exponentially to the fourth power.) Thus, for example, the rear axle of a typical 13-ton van causes over 1000 times as much damage as that of a car. Since trucks and buses cause almost all of the pavement damage, discussion of pavement wear charges is usually limited to them.

A marginal cost pavement wear charge can be assessed by multiplying a vehicle's esal-miles by the marginal cost of an esal-mile. For example, Small, Winston, and Evans (1989, p. 42) estimated the (average) marginal cost of an esal-mile on rural interstate highways to be 1.5 cents.[2] Thus, a truck equivalent to 2 standard axles traveling 100 miles on a rural interstate would accrue 200 esal-miles and a charge of $3.[3] Such a pavement wear charge would reflect much more accurately the damage caused by vehicles using the road. It would also give truckers an incentive to reduce axle weights by shifting to trucks with more axles, thus extending pavement life and reducing highway maintenance expenditures.

The fuel tax currently in use provides truckers with the opposite incentive: the tax rises with a vehicle's axles, since trucks with more axles require larger engines and get lower fuel economy. Another counterproductive incentive is that many state turnpikes charge more for a given weight if it is carried on a vehicle with many axles.

[1]Tolls are levied on some roads and eight states have adopted taxes that assess trucks according to their total weight and distance traveled, but such charges account for only a small share of highway revenues.

[2]The National Cooperative Highway Research Program calculated the average maintenance cost per esal-mile to be 1.6 cents (Transportation Research Board, 1986).

[3]New devices for weighing trucks in motion and improvements in microelectronic identification make it possible for firms and auditors to tabulate esal-miles accurately.

Optimal Pavement Durability

The damage that a truck does to a pavement depends not only on its axle weight but also on the durability (thickness) of the pavement.[4] Pavement thickness has been strongly influenced by guidelines from the American Association of State Highway and Transportation Officials (AASHTO). Small and Winston (1988) examined these recommendations, and found that AASHTO had failed to incorporate economic optimization into the design procedure (failing to minimize the sum of capital and maintenance costs) and had developed a relationship between pavement life and pavement thickness that was statistically flawed. As a result, they found that optimal thicknesses were significantly higher than current thicknesses, especially for heavily traveled interstates. For example, the optimal thickness for heavily traveled rigid concrete pavements is 13.8 inches compared with AASHO's estimate of 11.2 inches. Increasing thickness by 2.6 inches more than doubles the life of the pavement. Greater road thicknesses would substantially reduce annual maintenance expenditures and, because they would lower the marginal cost of an esal-mile, would also soften the impact of efficient pavement wear taxes on truckers.

The economic effects of building roads to optimal durability and of charging marginal cost pavement wear taxes to truckers are shown in Table 1. The effects of the first-best policy are shown in the first column of the table, while columns two and three show the results of partial implementation. Gains in net welfare from the first-best policy total $7.75 billion annually (in 1982 dollars), nearly 18 percent of total 1982 highway expenditures. The source of these benefits is a huge, roughly 75 percent, annual reduction in maintenance costs of nearly $10 billion, which is achieved with only a $1.2 billion annualized increase in capital costs. This policy is also politically attractive because it entails little redistribution; in fact, all major highway interests gain. Truckers and their customers gain because increased durability *lowers* the efficient road-wear charges from the charges that apply on today's roads. The public sector gains because trucking firms distribute their loads over more axles (change vehicle types) reducing standard loadings (esals) by 38 percent, reducing highway maintenance expenditures. Railroads gain slightly from an increase in traffic,[5] and the federal government's budget balance is improved because the reductions in maintenance expenses greatly offset the loss in highway revenues and increase in capital expenses.

The table also shows the importance of combining optimal pricing and investment. Setting efficient pavement wear taxes at current highway durability (middle column) would produce a smaller welfare gain and generate substantial

[4]Besides making pavement thicker, durability can also be improved by improving drainage, using better construction materials and other methods. Aging and weathering leave a pavement more vulnerable to heavy loads.

[5]Railroads gain because truck charges tend to rise on intercity traffic shipped long distances in large quantities; hence their business grows despite a small overall decrease in truck charges.

Table 1

Annual Economic Effects of Efficient Infrastructure Policy for Roads

(change, relative to current practice, in billions of 1982 dollars except as noted, positive dollar values indicate improvement)

Item	*Efficient Pricing and Investment*	*Efficient Pricing with Current Investment*	*Efficient Investment With Current Pricing*
Investment Costs			
Maintenance Savings	9.428	6.441	8.536
Annualized Capital Savings	−1.276	—	−2.236
Total Savings	8.152	6.441	6.300
Trucking Firms' and Shippers Welfare[a]	0.134	−5.586	—
Government Revenues	−0.574	3.884	—
Modal Shifting[b]			
Modal surplus	0.029	0.204	—
Rail Profits	0.011	0.411	—
Total Welfare	7.752	5.354	6.300
Change in Standard Loadings[c] (percent)	−38.12	−48.38	0.0

Source: Small, Winston, Evans (1989).

[a]These estimates do not include changes in user costs (vehicle damage and slower speeds due to damaged pavement). Small, Winston, and Evans (1989) point out there are difficulties in obtaining reliable estimates of this effect. Their rough estimates indicate that under optimal pricing and investment user costs are reduced by $3.03 billion when they are optimized along with maintenance and capital costs. User costs still fall by $1.8 billion under optimal pricing and investment when they are not explicitly optimized.

[b]Modal surplus measures the benefits to shippers who shift freight to or from railroads in response to the change in truck taxes.

[c]The reduction in standard loadings is accomplished with only a small change in ton-miles that results from modal shifting, most of the reduction is from truck-type shifts.

redistribution from the trucking industry to the public treasury. This finding confirms that truckers are currently being undercharged for their use of the roads, but it also reveals how inadequate infrastructure investment can penalize an industry.

Building roads to optimal durability while maintaining current pricing (last column) also produces a smaller welfare gain and requires greater capital outlays. Because optimal investment is a long-run policy and the benefits from reduced maintenance expenses will be seen only several years after initial capital outlays, the present value of which must all be incurred when a road is upgraded, extra capital expenses could arouse short-term budgetary concerns. Nonetheless, society would save $4 for every $1 spent, including interest, which is a healthy return.

Congestion Charges

Regardless of what policies are implemented to fight traffic congestions —from high-occupancy vehicle lanes to subsidies for public transit—delays get longer and drivers and passengers get angrier. At first sight, increasing highway capacity may appear as sensible as increasing highway durability, but capacity and durability inadequacies have different effects on road users. Few vehicles are discouraged from using a road because of its durability problems, so optimal durability produces benefits without significantly increasing use. On the other hand, because many motorists are discouraged from using a congested road, traffic will be attracted when capacity is expanded to relieve congestion. Benefits may be accrued by expanding capacity but congestion will persist in the long run (Downs's law). The only way to reduce congestion permanently is to set an explicit price for capacity.[6]

Congestion pricing has been advocated by economists for many years, but policymakers have either ignored it or dismissed it on political and practical grounds. For example, congestion pricing is not mentioned in *Time*'s (1988) eight-page cover story on gridlock. Ross Sandler, New York City Commissioner of Transportation (Pitt, 1989), dismissed the idea by saying, "What would you do—put tolls on all the highways?"

However, Small (1983) shows that objections by those who protest that lower income drivers would be unfairly penalized are unfounded. If toll revenues are used to lower property taxes, invest in public transit, or replace registration fees or fuel taxes, congestion pricing can benefit all income classes. Objections that tolls are impractical are also overstated. Congestion tolls varying by time of day, and imposed when congestion would otherwise persist, can be implemented without disrupting a traveler's journey. An automated vehicle identification (AVI) system, in which an electronic number plate is mounted underneath each vehicle, can be used to transmit a vehicle's numbered identification to a control center each time it passes over a power loop embedded beneath a toll site. The vehicle owner is then sent a monthly bill similar to a phone bill. Such a system has been tested in Hong Kong and found to perform exceptionally well. A sample of conclusions from the test includes the following: more than 99.7 percent of vehicles crossing a given toll site were correctly identified; security features could detect attempted fraud; and manual supplementary police enforcement at toll sites was proven feasible (Catling and Harbord, 1985). In the United States an AVI system is currently operating on the North Dallas Tollway and in New Orleans.

Because the effects of congestion pricing vary widely by locale, owing to different traffic densities and road systems, most studies of its effects have been

[6]Some have argued that the fuel tax is a surrogate for congestion pricing because cars tend to get lower fuel economy in heavy traffic. But fuel economy could actually improve if, for example, congestion forces cars to travel at moderate speeds (30 miles-per-hour) instead of higher speeds.

site-specific. But a study by Lee (1982) made a rough estimate of the effect of adopting congestion pricing nationwide and found that it would generate $5.65 billion (1981 dollars) in annual net benefits, mostly in the form of annual travel delay savings of approximately one billion vehicle-hours. If congestion pricing were accompanied by optimal investments in road capacity, then annual net benefits would be even higher and the initial redistribution from road users to the road authorities would probably be less.

Highway Finance and Additional Benefits

Although efficient road pricing and investment would generate substantial benefits, one must estimate the degree of scale economies in highway production to determine whether this policy would enable highways to be financially self-sufficient. Highways produce two "products:" traffic volume requiring capacity (number of lanes) and standard loadings requiring durability (thickness). Determining the economies of scale in this multiproduct case requires finding the economies for each specific product, and then the economies of joint production, commonly referred to as economies of scope. Small, Winston, and Evans (1989) find strong economies associated with producing standard loadings, because a pavement's ability to withstand traffic increases far more than proportionally with its thickness. They find evidence from the literature that there are mild economies from producing traffic volume. (A common explanation is that capacity goes up faster than the number of lanes; for example, two lanes in a given direction have more than twice the capacity of one lane.) However, they also find diseconomies of scope from jointly producing volume and standard loadings, because as the road is made wider to accommodate more traffic, the cost of any additional thickness required to handle heavy vehicles rises, since all lanes must normally be built to the same thickness. The result of combining these components is that the product specific economies are virtually offset by the diseconomies of scope, which leads to approximately constant returns to scale in highway production.[7]

These constant returns to scale imply that urban roads that are sometimes congested could be self-financing in the long run. For uncongested rural roads, additional charges such as license and registration fees would be required to attain a balanced highway budget.

This finding reveals an important additional benefit from congestion pricing. If efficient marginal cost pricing for road wear is undertaken alone, the road authority would face a deficit for urban roads, as well as rural roads, because of the economies of pavement durability.[8] But when efficient road wear

[7]Small, Winston and Evans (1989) discuss the possible efficiency gain from a road system that separates truck and auto traffic, which is motivated by their finding of diseconomies of scope. Such a system could be like the split of autos and trucks on the New Jersey Turnpike outside of New York City.

[8]Small, Winston and Evans (1989) find that the "pavement deficit" is reduced by optimal pavement wear pricing and investment from its current level of $16.16 billion (1982 dollars) to $9.84 billion

pricing is combined with efficient congestion pricing, the (marginal) cost of building the pavement itself is effectively charged twice: once from trucks because they require a thicker pavement and once from cars because they require a wider pavement. The result is that losses from pavement durability economies are eliminated.

As a further benefit, congestion pricing could substantially reduce the public transit operating deficit, which approached $9 billion in 1985 according to the Urban Mass Transportation Administration. Higher congestion tolls will cause some motorists to shift to public transit. For example, Viton (1983) finds that congestion pricing in the San Francisco Bay Area would raise mass transit's share of downtown commuters by 10-20 percentage points. This increased ridership will probably lead to buses or trains running more frequently, which will increase convenience and allow transit agencies to raise fares above inefficiently low levels but still attain more ridership.

Efficient highway infrastructure policy could also complement the effects of trucking deregulation. Instituted in 1980, motor carrier deregulation has benefited shippers by some $14 billion annually (1988 dollars) in lower shipping costs and better service (Winston, Corsi, Grimm, and Evans, 1990). Because of shippers' increased use of just-in-time inventory methods, which attempt to keep inventories to a minimum by bringing in raw materials just in time for production, frequent and reliable service has become especially important. Deregulation has also stimulated the trucking industry to make innovations in equipment, routing, scheduling, and communications.

Congested and damaged roads thwart the effectiveness of carrier innovations, cause travel delays that disrupt the just-in-time inventory process, and raise carrier operating costs through wasted fuel and vehicle damage. All these costs are eventually borne by consumers. Some recent proposals to combat congestion and pollution would ban trucks from downtown areas during certain parts of the day and raise shipping costs even higher. Efficient highway infrastructure policy could supplant potentially counterproductive proposals, and facilitate carriers' continuing efforts to minimize shipping costs.[9]

Efficient highway infrastructure policy is designed to make the best use of scarce durability and capacity. Scarce durability arises because roads can only withstand a finite number of standard loadings before they need resurfacing.

(1982 dollars). The pavement deficit is defined for the optimal and current policy as the difference between tax revenues and the annualized value of resurfacing expenditures and the cost of the paving material itself.

[9]Although they are not analogous to the problems with publicly owned roads, infrastructure problems could also arise in railroad freight service because rail infrastructure is privately owned and maintained. Winston, Corsi, Grimm, and Evans (1990) point out that rail's financial performance has improved because of deregulation and that no major changes in rail policy are currently warranted. But they also suggest that a radical policy initiative, separating ownership of the rail infrastructure from ownership of the operating companies, could be necessary in the event of an economic downturn to preserve rail's financial viability and to facilitate sufficient railroad competition.

Efficient road wear pricing attempts to reduce loadings by forcing shifts to trucks with fewer loadings; efficient investment recommends road design that allows roads efficiently to withstand a greater number of loadings. Each policy extends road life and saves society maintenance expenses; together they reduce maintenance expenses even more and, most importantly, they minimize redistribution and thus political problems. Scarce capacity is effectively rationed by congestion pricing; such capacity only can be used by those motorists willing to pay an efficient premium for it. With efficient highway infrastructure policy in place, authorities are able to make efficient decisions about whether building new roads can be economically justified.

Efficient Airport Pricing and Investment

Airport congestion and flight delays are receiving increasing public attention. The Department of Transportation has tried to coax airlines into improving their reliability by publicizing each carrier's on-time performance. Many observers argue the problem stems from a lack of airport capacity, citing the fact that no new major airports have been built since 1974. There are many supporters of federal subsidies for a new Denver airport, estimated to cost $2.5 billion.

Although additional airport capacity is not likely to attract as much traffic as additional highway capacity, the tremendous increase in aircraft departures of more than 25 percent during the past decade, partly spurred by deregulation, and the high cost and long lead times associated with new airports suggest that society will be faced with a difficult and expensive catch-up task if it commits itself to reducing air congestion by building more airports. A less costly and more effective solution is to price and invest in existing airports more efficiently.

Efficient Runway Pricing and Capacity

The most common way of assessing landing fees at airports is by aircraft weight. Thus, a commercial jumbo jet pays considerably more to land during a given hour than a small private plane (general aviation). Weight-based landing fees were probably a reasonable way to allocate airport costs and raise revenue when airports were uncongested, but today, the principal cost that an aircraft imposes when it takes off or lands is that it delays other aircraft. (Runway damage caused by aircraft is small.) Morrison and Winston (1989b) found that this delay can be substantial. For example, the elasticity of average departure delay, defined as the percentage change in average departure delay caused by a 1 percent change in aircraft departures, is 2.9 for commercial carriers. This is similar to general aviation's elasticity of 2.5. Current weight-based landing fees undercharge aircraft in inverse proportion to their weight because they do not account for the congestion externality.

An airport's capacity is primarily determined by its number of runways, although terminal facilities and gate space can also have some effect. If an airport already owns the land, an additional 10,000 foot × 150 foot runway can be constructed for roughly $40 million in 1987 dollars (Morrison and Winston, 1989b). Optimal runway capacity is reached when the marginal cost of an additional runway is equated with the marginal benefit of reduced delay. The benefits of reduced delay are mainly the time saved by air travellers. Morrison and Winston (1989b) estimate average delay to be just a few minutes at some airports but as high as 27 minutes at New York (La Guardia) airport. They also estimate commercial air travelers' hourly value of time to be $42 (1988 dollars) and account for the number of passengers carried by different types of aircraft. Thus, for example, the passenger delay cost imposed on a commercial jet landing at La Guardia approaches $2,000. The effects of replacing weight-based landing fees with marginal cost congestion fees and of building the optimal number of runways at airports is shown in Table 2.[10] The effects of efficient runway pricing and investment are shown in the first column of the table, and the effects of adopting efficient runway pricing at current runway investment are shown in the second column.

Optimal airport pricing and investment policy could generate roughly $11 billion (1988 dollars) in annual benefits. Travelers reap $8 billion in reduced delay and also would pay lower fares because the expansion in runway capacity called for under optimal investment combined with congestion pricing would reduce congestion to such an extent that, on average, landing fees would fall.[11] The annualized cost of the additional runway investment is only about $1.5 billion. Carriers benefit from the lower operating costs from reduced delay. Airports' net revenues would fall slightly, but, as we argue below, they would become financially self-sufficient.

The combination of efficient pricing and efficient investment policies is again economically and politically important. If airports adopted efficient congestion fees alone, there would be considerable redistribution from travelers —who would primarily absorb the higher takeoff and landing fees through higher fares—to airports. The losses to commercial travelers could be softened by reductions in the 8 percent ticket tax used to support air traffic control and airport construction. But general aviation, which would face the largest user fee

[10]Optimal runway capacity is determined under the assumption that no additional land is needed for runway expansion. Although this assumption is unreasonable for some airports, other capacity-enhancing mechanisms are or will be available that could by themselves produce a similar effect or enable runways to be built closer together at airports with limited room for growth. These mechanisms include high-speed runway exits, microwave landing systems, phased array radar, and digital pilot-air traffic control communications. In any case, this assumption produces an upward bias in the estimate of net benefits.

[11]General aviation travelers will face higher landing fees. But the Morrison-Winston model does not account for the greater flexibility that general aviation travelers have in their choice of airport and arrival and departure time, thus their loss is overstated.

Table 2
Annual Economic Effects of Efficient Infrastructure Policy for Airports
(change, relative to current practice, in billions of 1988 dollars, positive values indicate an improvement)

Item	*Efficient Pricing and Runway Investment*	*Efficient Pricing Current Runway Investment*
Consumer surplus change from landing and takeoff fees[a]	1.10	−12.53
Reduced delay to travelers	7.91	3.62
Carriers' operating cost savings	2.77	1.23
Airport revenues less costs	−0.77	11.50
Total welfare change	11.01	3.82

Source: Morrison and Winston (1989b), pp. 61–112.
[a]The consumer surplus change measures the effect of changes in landing and takeoff fees on travelers who continue to fly and those who are driven from or attracted to airline travel.

increase, would remain uncompensated and mount heavy opposition to this change.[12]

Combining efficient pricing and investment would postpone the need to build expensive new airports. The FAA estimates that the new Denver airport will reduce current delays at the Denver Stapleton airport by 35 percent to 50 percent. Optimal pricing and investment at Stapleton would lower delays by at least that much at lower costs (Morrison and Winston, 1989b). Continued growth in air travel will eventually necessitate constructing new airports, but these decisions will be made more efficiently if we make better use of our current airport capacity.

Because airports are characterized by overall constant returns to scale (Morrison, 1983), they would be financially self-sufficient under optimal pricing and investment. Their self-sufficiency would help lower the federal government deficit because airports would not need funds from the government to finance improvements.

Efficient Air Transportation Policy and Deregulation

Deregulation of the airline industry has been a success. Morrison and Winston (1986, 1989a) find that deregulation has provided travelers and

[12]General aviation was successful in its opposition to the landing fee increase at Logan (Boston) Airport. But the revised prices at Logan were only applied to small aircraft (fees were actually lowered for larger planes to keep the plan revenue neutral) and were not differentiated by time of day.

carriers with $14.9 billion of annual benefits (1988 dollars).[13] But by lowering fares and accelerating the development of hub and spoke route structures, deregulation has increased the flow of traffic at major airports, which has strained airport capacity and caused delays. Despite popular belief, the source of the delays is not deregulation per se but the failure of airports to undertake optimal pricing and investment. The increased flying activity in the deregulated environment makes this failure all the more costly; Morrison and Winston (1989b) estimate that the potential benefits of deregulation have been lowered by at least $2 billion because of greater travel time.

Today, all airports in the U.S. are publicly owned, usually by local government agencies. Airports' contributions to investments in capacity are financed by bonds that are effectively guaranteed by the airlines. Efficient pricing and investment could reduce the airlines' control over airport investments, especially ones that would enable competitors to have easier access to the airport, because airports would be financially self-sufficient. It has been argued that under use agreements between airlines and airports, airlines can block airport investments in capacity that require them to pay additional fees. By expanding capacity, efficient pricing and investment could also reduce entry barriers that exist at certain airports because carriers are unable to get takeoff and landing slots. (Of course, these additional competitors would need to obtain gate space, also.) New entry could be facilitated, putting downward pressure on fares and adding to the benefits from deregulation.

Toward Efficient Infrastructure Policy

The potential exists to realize substantial benefits from an efficient infrastructure policy. The annual welfare gain from efficient pricing and investment of highways and airports advocated here approaches $25 billion, and it can be obtained for only about $2.7 billion in annualized capital expenditures to increase road thickness and to build more runways. Benefits would actually be higher than these estimates suggest because performance in the deregulated airline and trucking industries would improve. And efficient infrastructure policy can at the same time effectively address the major concerns with deregulation, air travel delays and entry barriers at airports. The conclusion is clear and inescapable: public spending on infrastructure should certainly be increased, but it should be done efficiently and be accompanied by efficient

[13]This positive conclusion has been corroborated by a recent study (Morrison and Winston, 1990) that compares deregulated and hypothetically regulated air fares since deregulation in 1978 through 1989.

pricing. Indeed, efficient pricing is a prerequisite to making efficient infrastructure investments.[14]

Leadership at the federal level would help shape an efficient infrastructure policy. One useful step would be for the federal government to require that requests for federal grants for highway and airport capacity improvements include a plan to reduce capital needs by efficient pricing and efficient investment. Unfortunately, current federal policy as stated in the National Transportation Plan (U.S. DOT, 1990) only mentions efficient pricing and investment in a vague way, if at all, and usually refers to it in connection with inefficient policies.

The best hope for sensible policy reform may reside with the states. Oregon has recently introduced an axle-weight tax for selected trucks and several locales in California are seriously exploring congestion pricing. There has also been support in California newspapers for congestion pricing (see the editorials cited in Small, Winston, and Evans (1989), p. 92). These states have recognized (and perhaps others will too) that the current federal emphasis on supporting increases in infrastructure spending with such means as higher state gasoline taxes will fail to provide a permanent solution to recurring infrastructure problems. Steps must be taken to stop passing these problems on to future generations.

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[14]Some readers may be familiar with the work of Aschauer (1989), who estimates time series regressions that attempt to explain the impact of the nonmilitary public capital stock on the nation's productivity, and finds very powerful effects. In fact, the effects he finds are too powerful.

Consider a one-time lump-sum $60 billion increase in infrastructure spending. An increase of this magnitude in 1985 would enable public works capital spending to regain its 1960 share of GNP. This lump-sum investment represents a 6 percent increase in the value of the infrastructure stock. Using Aschauer's elasticity estimate of .24 for the change in productivity with respect to the change in the infrastructure capital stock leads to a 1.4 percent increase in current output from the investment or a $70 billion gain in the first year. With conservative parameters, the present value of the gain in future years would exceed $600 billion, for a benefit-cost ratio of 10:1.

This return is implausible. Charles Schultze (1990) argues Aschauer's findings simply demonstrate that the time pattern of productivity and public investment growth are similar (both rising in the 1950s and 1960s, and both falling in the 1970s and 1980s), and that this correlation generates grossly inflated estimates of the return to public infrastructure investment.

References

American Association of State Highway and Transportation Officials, *AASHTO Guide for Design of Pavement Structures*, Washington: AASHTO, 1986.

Aschauer, David Alan, "Is Public Expenditure Productive?" *Journal of Monetary Economics*, March 1989, *23*, 177–200.

Catling, Ian, and Brain J. Harbord, "Electronic Road Pricing in Hong Kong, 2: The Technology," *Traffic Engineering and Control*, December 1985, *26*, 608–615.

Downs, Anthony, "The Law of Peak-Hour Expressway Congestion," *Traffic Quarterly*, July 1962, *16*, p. 393.

Governors' Task Force Report, Presented to National Governors Association, Chicago, IL, August 1989.

Joint Economic Committee, United States Congress, "Public Investment in Infrastructure," July 1989.

Lee, Douglas B., "New Benefits From Efficient Highway User Charges," *Transportation Research Record*, 1982, no. 858, 14–20.

Mohring, Herbert, and Mitchell Harwitz, *Highway Benefits: An Analytical Framework*, Evanston, IL: Northwestern University Press, 1962.

Morrison, Steven A., "Estimation of Long-Run Prices and Investment Levels for Airport Runways," *Research in Transportation Economics*, 1983, *1*, 103–130.

Morrison, Steven, and Clifford Winston, *The Economic Effects of Airline Deregulation*, Washington, DC: The Brookings Institution, 1986.

Morrison, Steven A., and Clifford Winston, "Airline Deregulation and Public Policy," *Science*, August 1989a, *245*, 707–711.

Morrison, Steven A., and Clifford Winston, "Enhancing the Performance of the Deregulated Air Transportation System," *Brookings Papers on Economic Activity: Microeconomics*, 1989b, 61–112.

Morrison, Steven A., and Clifford Winston, "The Dynamics of Airline Pricing and Competition," *American Economic Review, Papers and Proceedings*, May 1990, *80*, 389–393.

Pitt, David E., "Tolls or No, Traffic Gets Worse," *New York Times*, September 1989.

Schultze, Charles L., "The Federal Budget and the Nation's Economic Health." In Aaron, Henry, ed., *Setting National Priorities: Policy for the Nineties*. Washington, DC: The Brookings Institution, 1990.

Small, Kenneth A., "The Incidence of Congestion Tolls on Urban Highways," *Journal of Urban Economics*, January 1983, *13*, 90–111.

Small, Kenneth A., and Clifford Winston, "Optimal Highway Durability," *American Economic Review*, June 1988, *78*, 560–569.

Small, Kenneth A., Clifford Winston, and Carol A. Evans, *Road Work: A New Highway Pricing and Investment Policy*, Washington, DC: The Brookings Institution, 1989.

Time, "Gridlock! Congestion on America's Highways and Runways Takes a Grinding Toll," September 12, 1988, 52–60.

Transportation Research Board, National Cooperative Highway Research Program, "Relationships Between Vehicle Configurations and Highway Design," National Research Council, Washington, DC, November 1986.

United States Department of Transportation, *Moving America: New Directions, New Opportunities*, Washington, DC, February 1990.

Viton, Philip A., "Pareto-Optimal Urban Transportation Equilibria," *Research in Transportation Economics*, 1983, *1*, 75–101.

Winston, Clifford, "Conceptual Developments in the Economics of Transportation: An Interpretive Survey," *Journal of Economic Literature*, March 1985, *23*, 57–94.

Winston, Clifford, Thomas M. Corsi, Curtis M. Grimm, and Carol A. Evans, *The Economic Effects of Surface Freight Deregulation*, Washington, DC: The Brookings Institution, 1990.

Mr. VALENTINE. Thank you very much, Mr. Winston. We have a markup of three bills scheduled for this place beginning five minutes ago and so I will submit perhaps questions to you in writing. You will be able to avoid the very penetrating cross examination of the members of this committee. I'm sure that you were looking forward to that. The next time you come see us, we'll put you at the top of the list. We do thank you very much for your appearance.

I think I have the consent of my colleagues to submit any questions.

Mrs. MORELLA. You do. Very provocative testimony. We will read the article too and submit questions as the Chairman has suggested. Thank you.

[No questions were submitted.]

Mr. VALENTINE. Thank you so much. This, I believe, concludes our hearing.

[Whereupon, at 11:39 a.m., the subcommittee adjourned, to reconvene at the call of the Chair.]

SURFACE TRANSPORTATION R&D

TUESDAY, APRIL 16, 1991

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10:09 a.m. in room 2325, Rayburn House Office Building, Hon. Tim Valentine [chairman of the subcommittee] presiding.

Mr. VALENTINE. Ladies and gentlemen, we will get started with the subcommittee hearing.

Mr. Lewis, ranking member, will be here shortly I am advised.

Good morning, ladies and gentlemen. This is our second hearing on Research and Development for Surface Transportation. There are a number of exciting technologies that offer the potential for safer, for faster, and less- polluting ways of getting to work, shopping, and visiting family and friends. Our objective here today is to learn more about some of these technologies like maglev, like intelligent vehicle highway systems, and traffic control and supporting infrastructures.

In today's budget climate we do not want to support systems which will be found too costly or impractical. On the other hand, what looks costly today may be affordable tomorrow through the advent of new technologies. In all cases we need to develop systems which will be accepted by the public. We also need to develop new technologies for maintaining our transportation infrastructure. The repair of highways using new materials could decrease the time the highway is out of service from months to hours.

Finally, we need to consider these new means of transportation as subsystems that can be efficiently interconnected in order to provide the flexibility and convenience which the public needs.

We look forward to today's testimony and to continuing with our studies in this area in an attempt to assure the effectiveness of the transportation systems of tomorrow.

[The prepared statement of Mr. Valentine follows:]

OPENING STATEMENT

SURFACE TRANSPORTATION HEARING

10:00 AM, TUESDAY, APRIL 16, 1991

ROOM 2325

GOOD MORNING LADIES AND GENTLEMEN. THIS IS OUR SECOND HEARING ON RESEARCH AND DEVELOPMENT FOR SURFACE TRANSPORTATION. THERE ARE A NUMBER OF EXCITING TECHNOLOGIES THAT OFFER THE POTENTIAL FOR SAFER, FASTER, AND LESS POLLUTING WAYS OF GETTING TO WORK, SHOPPING, AND VISITING FAMILY AND FRIENDS.

OUR OBJECTIVE HERE TODAY IS TO LEARN MORE ABOUT SOME OF THESE TECHNOLOGIES LIKE MAGLEV, INTELLIGENT VEHICLE HIGHWAY SYSTEMS, TRAFFIC CONTROL AND SUPPORTING INFRASTRUCTURES.

IN TODAY'S BUDGET CLIMATE, WE DO NOT WANT TO SUPPORT SYSTEMS WHICH WILL BE FOUND TOO COSTLY AND IMPRACTICAL. ON THE OTHER HAND, WHAT LOOKS COSTLY TODAY MAY BE AFFORDABLE TOMORROW THROUGH THE ADVENT OF NEW TECHNOLOGIES. IN ALL CASES, WE NEED TO DEVELOP SYSTEMS WHICH WILL BE ACCEPTED BY THE PUBLIC.

WE ALSO NEED TO DEVELOP NEW TECHNOLOGIES FOR MAINTAINING OUR TRANSPORTATION INFRASTRUCTURE. THE REPAIR OF HIGHWAYS USING NEW MATERIALS, COULD DECREASE THE TIME A HIGHWAY IS OUT OF SERVICE FROM MONTHS TO HOURS.

FINALLY, WE NEED TO CONSIDER THESE NEW MEANS OF TRANSPORTATION AS SUBSYSTEMS THAT CAN BE EFFICIENTLY INTERCONNECTED IN ORDER TO PROVIDE THE FLEXIBILITY AND CONVENIENCE THE PUBLIC NEEDS.

WE LOOK FORWARD TO TODAY'S TESTIMONY AND TO CONTINUING WITH OUR STUDIES IN THIS AREA IN AN ATTEMPT TO ASSURE THE EFFECTIVENESS OF THE TRANSPORTATION SYSTEMS OF TOMORROW.

Mr. VALENTINE. Mr. Roemer? We recognize the distinguished gentleman from Indiana at this time, Mr. Roemer. At this time if you have an opening statement we would be glad to hear from you.

Mr. ROEMER. Mr. Chairman, I'm just delighted to be here to join with you this morning. Just a very brief opening statement commending you for the second hearing on such an important topic as our infrastructure concerns, developing new and better R&D efforts. It seems that in our country that we are so proud of new technologies and we have led the world in this effort over the last 25 to 50 years. We are very, very strong on the research end, and we need to put more emphasis on the development end, bringing these technologies to the market place, creating jobs, improving our infrastructure, and thereby improving our competitiveness.

As we read the different studies, Mr. Chairman, about the transportation problems, I hear about them all the time from my farmers and my businesses how it costs us all kinds of money over the course of a year in getting our products to the market place and competing internationally. I think this is an area that we really need to concentrate in and also, when we read the frightening studies about the amount of highways and bridges that are in dire need of repair, that we do focus upon the technology, research, and development end, and I'm glad to see our committee focusing on this, Mr. Chairman. I salute your efforts to bring this before our committee in such an expeditious manner.

Mr. VALENTINE. Thank you.

We have been joined by the distinguished gentleman from California, Mr. Dana Rohrabacher. Dana, do you have an opening statement?

Mr. ROHRABACHER. Mr. Chairman, in California we have incredible traffic jams. I'm one of the biggest backers of the national aerospace plane in Congress, I guess, joined with yourself and about ten others. We have been pushing the National aerospace plane, and if we ever get that done we're going to be able to fly from Los Angeles to Tokyo in about an hour. Of course, it will take about an hour and a half to get through the airport traffic just to park your car.

I think that as we prepare for the future it is important that we prepare not only for aviation and space, but also for making sure that technology helps solve some of our transportation problems on the ground. I am a firm believer that technological developments in the last decade, if we can put them to use, that America will increase her productivity and help us become more competitive with our competition as we enter a new era now of post-cold-war era.

I am very anxious to work with your, Mr. Chairman, in the years ahead to make sure that America does reach her potential in this vital technological arena.

Thank you.

Mr. VALENTINE. Thank you, Mr. Rohrabacher.

We have been joined by the distinguished ranking member of the subcommittee, the gentleman from Florida, Mr. Lewis.

Mr. LEWIS. Mr. Chairman, it is nice to be with you this morning.

Mr. VALENTINE. Very good. Our first panel consists of Doctor Steven Shladover, Technical Director of the Program of Advanced Technology for the Highways, I guess, at the University of Califor-

nia, Berkeley Institute of Transportation Studies—if you would come around, Doctor; and Mr. Haack, Alan H. Haack, appears. He is not here yet, but we invite him to come on up to the table when he gets here. He is Transportation Policy Committee, Port of New York-New Jersey. Also on this panel is Mr. Robert French from Robert French Associates at Fort Worth, Texas.

Welcome, gentlemen. We encourage you to summarize your statements. Your prepared statements will appear in the record as submitted to us.

Mr. Haack?

Mr. HAACK. Yes, I am.

Mr. VALENTINE. He experienced the traffic jam that Mr. Rohrabacher was talking about.

Mr. HAACK. I experienced high-speed rail transportation.

Mr. VALENTINE. Dr. Shladover?

STATEMENT OF DR. STEVEN SHLADOVER, TECHNICAL DIRECTOR, PROGRAM OF ADVANCED TECHNOLOGY FOR THE HIGHWAY, UNIVERSITY OF CALIFORNIA, BERKELEY INSTITUTE OF TRANSPORTATION STUDIES; ACCOMPANIED BY: DR. E. HARRY LAW, PROFESSOR OF MECHANICAL ENGINEERING, CLEMSON UNIVERSITY

Dr. SHLADOVER. Mr. Chairman and members of the subcommittee, I am Doctor Steven Shladover, Technical Director of the PATH Program at the Institute of Transportation Studies of the University of California, Berkeley. I am accompanied today by Doctor E. Harry Law, Professor of Mechanical Engineering, from Clemson University. We are here in our capacity as members of the special 21-member task force of the American Society of Mechanical Engineers—ASME—on surface transportation R&D needs. The views expressed in our statement are representative of the experts on the task force rather than the ASME as a whole.

Above all, we would like to emphasize the importance of system-level thinking in the formulation of transportation research, development, and implementation plans.

The transportation problems in mobility, safety, productivity, energy, and environment are so closely coupled that they cannot be addressed in isolation from each other but must be addressed in a coordinated fashion. It is vital to recognize that single-approach technologies will not provide magical solutions and that significant improvements will generally be gained only by application of system-level solutions.

We must also remain conscious of the need to start with the definition of the problems that we are trying to solve and to proceed from that to the identification of solutions. This is vital if we are to avoid the trap of focusing on solutions that are looking for problems.

The written statement of the task force addresses a wider range of issues than we can hope to cover in our limited time this morning, but we will try to highlight a few of the key issues.

We will begin with intelligent vehicle highway systems — IVHS—as one of the most significant current subject areas in surface transportation, both because of the magnitude of the road

transportation problems we face and the potential of IVHS for alleviating them. We will also cover some other R&D issues related to road transportation and high-speed ground transportation.

Present-day roadways and road vehicles are designed, developed, and operated independently of each other. This uncoordinated approach is in marked contrast to most of our other transportation modes. Significant improvements in the operation of the road system should be achievable by coordination between the roads, the vehicles, making use of modern computer, communication, and control technology.

The really significant increases in road system capacity and safety will be gained from application of the more advanced IVHS technologies that involve automatic control of driving functions. It should be less cheaper and less environmentally intrusive to provide major road system capacity increases by means of vehicle control technology than by construction of more lane miles of freeway. The environmental and petroleum consumption impacts of potential increases in vehicle miles travelled can be counteracted by use of the related technology of highway electrification, which provides battery-electric vehicles with sufficient range to operate for a full day so that they can effectively compete with internal combustion engine vehicles.

The complicated system engineering and advanced vehicle control technologies needs public sector R&D attention because of their technical difficulty and their potentially very large benefits, coupled with long gestation periods that make it difficult for the private sector to find near-term paybacks.

The task force identified several issues associated with the safety of trucks with multiple trailers. For instance, in obstacle avoidance maneuvers multi-trailer vehicles may experience a cracking-the-whip phenomenon in which the motions of the rear trailers are larger than the motion of the tractor. The problem is even more serious for high-center-of-gravity vehicles which, under certain conditions, are prone to rolling over.

Research is underway to understand these phenomena and develop means to alleviate them; however, the issues have not been completely resolved to date.

Other safety-related research issues identified by the task force include: advanced electronically coupled controlled suspensions to help reduce driver fatigue and pavement wear and improve stability in handling of the vehicles; analysis tools needed to predict the behavior of composite materials in collision situations; and sacrifices in wet traction and wearability in tires resulting from requirements for low rolling resistance in order to meet increased fuel efficiency standards.

Finally, our task force considered high-speed rail and magnetically-levitated transportation systems. Views of the task force members with regard to maglev ranged from skepticism to enthusiasm. Skeptics maintain that foreign technology is far ahead of U.S. technology and the economics are not favorable or competitive with other modes, while the enthusiasts argue that advances in superconducting materials and the integration of maglev into major hub airport operations justify investments in its technology.

High-speed rail technology was also viewed by the task force as an alternative to air travel for inter-city corridor applications, but research would be required on wheel-rail effects at high speeds and perhaps on the propulsion system technology for very high speeds.

As an indication of the importance that ASME attaches to transportation technology, the theme of this year's annual meeting of the ASME, to be held in December in Atlanta, is Transportation in the 21st Century.

I would like to close by noting that the professional engineering community, represented by organizations such as ASME with its broad mechanical engineering expertise, and comprised of members from industry, academia, and government, can serve as qualified, unbiased advisors to the Congress and to the Federal agencies responsible for overseeing the development of surface transportation technologies. We stand ready to serve in this role.

Mr. Chairman, that completes my statement. We would be happy to answer any questions you may have.

[The prepared statement of Dr. Shladover follows:]

The American Society of Mechanical Engineers

Suite 218
1825 K Street, N.W.
Washington, DC 20006-1202
202-785-3756

Statement of the

Task Force on Surface Transportation

of the

Council on Engineering

of the

American Society of Mechanical Engineers

on

Surface Transportation Research and Development Needs

Presented to the

Subcommittee on Technology and Competitiveness

of the Committee on Science, Space and Technology

of the

U.S. House of Representatives

April 16, 1991

Mr. Chairman and Members of the Subcommittee.

I am Steven Shladover, Technical Director of the Program on Advanced Technology for the Highway (PATH) at The University of California, Berkeley Institute of Transportation Studies. I am accompanied today by Dr. E. Harry Law, Professor of Mechanical Engineering at Clemson University. We are here in our capacity as members of a task force of the Council on Engineering of the American Society of Mechanical Engineers (ASME) on Surface Transportation R&D needs.

We are pleased to respond to the subcommittee's request to present our views and recommendations on the technology issues that must be addressed in order to establish a reliable, safe, environmentally sound, energy conserving, and cost effective surface transportation network for the nation.

This is certainly a tall order, and we make no pretense at providing all the answers to these vexing and complex problems. Nevertheless, we hope that our testimony will assist the subcommittee in identifying some of the critical engineering problems that must be resolved in order to meet the projected surface transportation needs of our society.

I must preface my remarks by noting that this ASME task force is comprised of experts in the field. The views expressed here are representative of this group, rather than the ASME as a whole. A listing of the Task Force participants is included as an appendix to this statement.

We cannot over-emphasize the importance of system-level thinking as policymakers develop a national transportation policy. Efforts must be oriented toward solving groups of problems rather than individual problems. It is vital to recognize that single-approach technologies will not provide "magical" solutions. In transportation, we need to be considering the closely interactive issues of mobility, productivity, safety, energy and environment at the same time.

In this testimony, we will address several technological developments that are presently underway, planned, or recommended that would provide some engineered solutions to these highly interactive transportation system problems. We will begin by discussing issues associated with vehicle-highway systems.

Intelligent Vehicle Highway Systems (IVHS)

Present-day roadways and road vehicles are designed, developed, and operated independently of each other. There is no communication between the two and there have been no real attempts at treating them as a combined system. This uncoordinated approach is in marked contrast to most of our other transport modes. Significant improvements in the operation of the road system should be achievable by coordination and communication between the roads and vehicles, making use of modern technological developments in the emerging field known variously as Intelligent Vehicle/Highway Systems (IVHS), or Road Transport Informatics (RTI).

Use of the IVHS technologies should help reduce the traffic congestion that plagues most of our urban areas, while reducing the accidents that impose such a severe health and economic burden on our country. The more advanced IVHS technologies, which involve some automatic control of driving functions, have the potential of greatly increasing the capacity of our existing roadway infrastructure, enabling it to handle much of the anticipated growth in travel and reducing the delays associated with both recurrent and non-recurrent congestion. It will be much cheaper and less environmentally intrusive to provide this capacity increase via automatic vehicle control than via construction of more lane-miles of freeway. The environmental (and petroleum consumption) impacts of the potential increases in vehicle miles travelled can be greatly reduced by the use of the related technology of roadway electrification. This would provide battery electric vehicles with sufficient range to operate for a full day so that they could effectively compete with internal combustion engine vehicles.

IVHS-related technology that has been proposed for R&D investment by the automotive industry includes the Advanced Traveller Information Systems (ATIS) program. These systems would provide real-time traffic information and route guidance to drivers, while allowing the exchange of information between the traffic information infra-structure and vehicles operating on the road network. The R&D efforts needed to support ATIS development would involve'', simulation of urban traffic networks, development of the data base for the system, development of the communication links, human factors of the ATIS driver interface design and a host of other tasks.

Of particular interest to the task force were more advanced IVHS technologies involving some automatic control of driving functions and having the potential to greatly increase the capacity of our existing roadway infrastructure, enabling it to handle much of the anticipated growth in travel and thereby reducing delays. We feel that sufficient emphasis needs to be placed on Advanced Vehicle Control Systems (AVCS), because these are the only systems that have the potential to produce dramatic (as opposed to incremental) improvements.

While there is current interest in vehicle-centered and highway technologies, we are concerned that the technologies that connect the two may be relegated to low priority. Consequently, the high payoff likely to occur from truly cooperative vehicle-highway systems may not occur for a very long time. We recommend that important areas like comprehensive system-level engineering and standardization for communications and components not be overlooked as this will pose a real problem when aspects of integration are finally addressed.

The research, development, demonstration and deployment of full-scale IVHS technology will require a significant national commitment, possibly approaching Project Apollo in scope. Recall that Project Apollo was motivated by the need to recapture national pride after the shock of the Soviets' Sputnik and manned space flight successes. IVHS has its own "Sputniks" today, but they come from Europe and Japan, where there are major national and international programs, involving cooperation between governments and industry, and the joint investment of more than a billion dollars, to develop

IVHS technologies. Their emphasis is on improving the competitive positions of their motor vehicle and electronics industries in the world export markets. We are already familiar with what has happened to the consumer electronics industry in the United States, and the danger signs are there for the automotive industry as well. If the United States does not embark on an aggressive IVHS program, we will soon be importing the IVHS technology and even more cars from overseas. If anything, this would serve as a more tangible threat to our national security and economic well-being than the Sputnik was.

Safety Issues Associated with Trucks with Multiple Trailers

Given the large mass of these vehicles, serious consequences are likely to ensue from crashes involving them. Hence research on pre-crash or accident avoidance measures is particularly important. Heavy trucks with multiple trailers have stability and control characteristics that, in some cases, are much like those of other heavy vehicles, and in other cases, depend upon the hitching arrangements and vehicle layout involved with using multiple trailers. The following practical goals for vehicle performance in safety-related maneuvers are the basis for the list of safety issues presented here:

* The rear of the vehicle should follow the path of the front of the vehicle with adequate fidelity in order to avoid collisions with obstacles.

* The vehicle should safely attain a desired level of deceleration during braking.

* The vehicle should remain upright (not roll over).

* The vehicle should be controllable and stable in following a desired path.

1. Obstacle Evasion (Rapid Emergency Maneuvering to Avoid Crash):

In obstacle avoidance maneuvers, multi-trailer vehicles (doubles and triples) may experience a "cracking-the-whip" phenomenon in which the lateral accelerations and motions of rear trailers are considerably amplified versions of the motion of the tractor pulling the combination vehicle.

Since the discovery of this phenomenon in connection with rollovers of doubles-combinations hauling gasoline, there have been efforts to develop the technology needed for reducing the amount of rearward amplification associated with this phenomenon. These efforts have produced considerable understanding concerning those mechanical properties that are pertinent characteristics of vehicles with large amounts of rearward amplification. They have also led to the development of innovative hitching mechanisms and dollies for interconnecting semitrailers in a manner that reduces this safety problem. Nevertheless, the issue has not been completely resolved, and

more effort and creative invention are needed to achieve the productivity advantages that these vehicles can provide without increasing accident hazards beyond those of the current vehicle fleet.

2. Braking With the Vehicle Under Directional Control:

The quality of the overall braking system as an accident avoidance mechanism depends upon the ability to stop quickly in a stable and controllable manner. Stability and control during braking depend upon avoiding wheel locking; and antilock braking systems (ABS) have been developed for this purpose. These systems are currently being re-introduced for heavy trucks in the U.S. Currently there is need for investigation of the influences of these ABSs on the braking and stability of multi-trailer combinations during turning on slippery surfaces.

Central to the function of the brake is the management of thermal energy. To reject more heat to the atmosphere requires either more cooling airflow or higher temperatures, neither of which is easily achieved with air powered drums. If heat cannot be rejected promptly the only alternative is to store it in a drum for later cooling. This approach is used in aircraft where repeated use of the brakes is unlikely. However, for a massive road vehicle it is a poor compromise, with potentially disastrous results.

Research into the thermal characteristics of truck drum brakes and their interaction with their surroundings is essential. This would determine whether or not the basic design is capable of further improvement or if it is time to abandon interchangeability as a design criterion.

3. Rollover:

Heavy vehicles with high centers of gravity are prone to rolling over. The level of lateral acceleration sufficient to roll over heavy trucks can be reached in accident avoidance maneuvers and on exit ramps taken at too high a speed.

A technical issue associated with multiple trailer vehicles has to do with how much each trailer contributes to holding up its neighbor in a transient maneuver. As in the case of rearward amplification, work on the design of hitching mechanisms is also pertinent. In addition, the general layout and design of the cargo space is important to controlling the height and lateral shift of the center of gravity of the laden vehicle. Risks associated with using multitrailer vehicles for hauling liquids and in particular, hazardous liquids, need to be considered. Although a lot is known about this safety issue, there is considerable need to develop vehicle designs that have outstanding productivity, great maneuverability, and adequate rollover thresholds for reducing the risks of accident involvements per amount of product delivered.

4. Path Following, Handling, and Offtracking:

There is some debate about the safety consequences of these items, although considerable attention is paid to them. Offtracking is particularly noticeable for long wheel base units in a combination vehicle. In fact, one of the reasons for using multi-trailer vehicles is to reduce offtracking at low speeds by breaking the vehicle into a number of shorter trailers. (This can be at the cost of increasing rearward amplification as discussed in Obstacle Evasion above.) The current doubles and triples employing "A-dollies" handle much like the front tractor-semitrailer portion of the vehicle because the A-dolly is very good at isolating the influences of the motion of the rear of the vehicle from those of the front. Through the arrangement of the A-dolly the rear of the vehicle follows well the path of the front at highway speeds in moderate maneuvers associated with normal driving. Hence there is considerable interest in reducing low speed offtracking and retaining the desirable properties of A-dollies if they are to be replaced with innovative dollies for safety reasons.

5. Suspension Systems:

Electronically controlled suspensions (semi-active and fully-active) can also play a significant role in improving the safety of heavy trucks, and by extension, trucks hauling multiple trailers. Major issues that these systems can address are driver fatigue (as will be discussed below), vehicle control, and road damage. It will be important to determine, through research, answers to questions such as:

* What positive effect can adaptive, semi-active, and active suspensions have in reducing fatigue in truck drivers?

* What improvements in braking can be made through the integration of braking and suspension systems?

* What improvement in tractor/trailer handling and controllability can be realized through the use of electronically controlled suspension systems?

* Can road damage and its resulting deleterious effects on safety be reduced through the use of electronic suspensions on heavy trucks?

There are technological countermeasures which could lead to new designs for more productive trucks whose features are compatible with preserving safety, increasing the mobility of moving goods, and maintaining the infrastructure. To achieve these types of countermeasures implies that safety, mobility, productivity, and preservation of the infrastructure will be considered simultaneously without over-emphasizing one aspect at the expense of another.

Engine and Powertrain, New Engine Concepts, Energy Efficiency, Alternative Fuels, Pollution Control, and Related Issues

Research funding should be directed in areas that show promise of large gains in fuel economy, significant reductions in exhaust emissions, or major decreases in production or maintenance costs. Major, non-incremental gains in fuel economy can be made by two types of powertrain or transmission systems (electric, hydraulic, mechanical or other means of variable coupling), and the second is by regenerative braking for urban vehicles. The basic need can be seen by estimating the difference between the energy needed to propel or stop the vehicle, and the energy produced by the engine. The engine, or prime mover, should operate near its maximum efficiency, aerodynamic and rolling forces must be minimized, and losses between these two must be identified and minimized. In a braking mode, regenerative braking systems, especially in large urban vehicles (city buses), could save large amounts of energy. Research in topics such as these, that have the promise of large improvements, is needed to conserve our natural resources and energy reserves.

In order to reduce harmful emissions, spark timing and fuel injection rate must be precisely controlled at judiciously selected levels. In the opinion of some researchers, spark timing control can be achieved relatively easily. However, fuel injection rate control is a much more difficult problem. If better means to design fuel injection control systems were available, the current emission levels would be reduced significantly. A leading option for reducing dependence on imported oil and reducing urban emissions is the substitution of natural gaseous fuel for oil based fuel. The availability of such fuels in North America from conventional sources (shallow wells) is greater by far than that of oil. The availability from unconventional sources (coal seams, geopressurized sources) has been estimated to be from 600 to 5000 years worth at current use rates.

A very important associated issue is the control of these systems, since their operation would require drive-by-wire energy management. Certainly, future driver control of vehicles will be by drive-by-wire systems, or systems directly controlled by computer(s) that receive input from the driver and vehicle dynamics. Automotive research is being, and should continue to be, directed toward these systems since direct driver controlled vehicles are in a highly refined state, and major improvements in vehicle response and safety will be realized by coordinating the subsystems (braking, steering, torque delivery, suspensions, etc.) to function in a unified or global manner. Research into coordinated control of several highly non-linear systems, with potentially large and varying modeling errors and strict performance requirements, is essential for realizing the improvements that can be demonstrated by computer simulation.

Safety-Related Research

A host of safety-related engineering tasks must also be considered for advanced highway transportation systems. Some of these potential research activities are now described.

1. Systems for Reducing Driver Fatigue:

It is important to be able to understand and measure the extent to which various systems in road vehicles contribute to or alleviate driver fatigue. One of the important interactions would be that of the driver with the steering system, i.e., is high effort/low feel less contributory to fatigue than low effort/high feel (as typified by some types of power steering)?

Electronically controlled suspensions (semi-active and fully active) are now available on production passenger cars. Work on these systems is also beginning to be done on both light and heavy trucks. The use of these systems for both primary and cab suspensions in heavy trucks will greatly improve their ride and handling. This will contribute to improving the safety of these vehicles directly through improved handling and control and indirectly through the alleviation of driver fatigue.

2. Structural Design and Crashworthiness - Technology Needs in Structural Composites:

Composite materials are expected to play a major role in improving the structural design and crashworthiness of highway vehicles. Analytic tools must be developed for designing automotive structures from light weight composite materials. Although automated structural design techniques are commonly used for metallic automotive structures, and non-linear structural analysis tools that can predict failure modes for metallics have advanced greatly in the past few years, these methodologies are not generally applicable to composites.

3. Tire Technology:

The motorcar industry will be strongly affected by increases in Corporate Average Fuel Economy levels (CAFE). The levels of rolling resistance that are now being specified for future vehicle programs cannot be obtained without a major technology breakthrough, added cost, or compromise of other performance.

For rolling resistance improvements, the trade-offs are wet traction and wear. Wet traction is directly correlated to driving safety. Rapid wear is not only costly to the consumer, but it also means more worn tires for the scrap piles, already a major concern to consumers.

The task force has identified the following areas for tire-related research:

1. application of new technology in tire design toward improving traction and wear while holding rolling resistance constant.

2. tire modeling research focused on evaluating existing tire models and developing new tire models as necessary.

3. investigation of the influence of the interaction of structural resonance effects of both vehicle and tire on ride integrity and tire noise. (Tire noise on both rough and smooth roads is an area of major concern and requires research effort).

We close our statement with a consideration of rail or guided surface transportation technologies. These include magnetically levitated, or Maglev, systems and high-speed rail.

Maglev - Magnetic Levitation

It is our understanding that this subcommittee's predecessors in the last Congress established a rather extensive record on magnetic transportation technologies. It is therefore unnecessary to belabor here the technological issues that must be resolved for Maglev to achieve commercial viability. Our task force expressed a range of views on the potentials of this mode of transportation. Suffice it to say that these views ranged from extreme skepticism (e.g. U.S. technology is behind, given the size of the lead that the Germans and Japanese already have, and the economics are unfavorable and non-competitive with other transportation modes) to fervent enthusiasm (e.g., advances in superconducting materials and engineering advances in magnetic levitation could give the U.S. an edge in international markets; new magnetic levitation transportation technologies can be used to relieve airport congestion and could be competitive with air for short distance express delivery industries). Some task force members supported federal R&D funding for Maglev as a future technology, somewhat analogous to the arguments for federal support of fusion energy research.

High-Speed Rail

A ride in the cab of a TGV Atlantic train traveling at 186 mph and the later news that this type of train achieved a speed of 300 mph on December 5, 1989 and 320 mph on May 18, 1990 leads one to speculate on even higher speeds for trains.

The ultimate achievable speed is open to question, but there are some other achievements which may provide us with clues. Here we are talking about railway vehicles where power is transmitted to the rails by the wheels. With respect to vehicles where the power is delivered through the wheel, speeds have been achieved by wheel driven automobiles of 658 kph (409 mph). These vehicles are not ultra-sophisticated according to standards developed by large industrial concerns, but they are developed by small groups of racing enthusiasts using commercially available components. If such power and speed can be achieved through rubber tires, the same should be true for steel wheels.

The development of wheel-rail transportation systems that are speed competitive with sub-sonic jet aircraft would require much less land area. The use of high-speed rail as an alternative to air travel in corridors of 100 to 750 mile range requires research of wheel-rail effects at speeds from 220 to 400 mph. The drive systems for such trains would require research in traction motor propulsion and systems using linear induction drive with wheel/rail support.

The task force feels that research funds on high-speed rail would be most efficiently spent on the improvement and adaptation of existing wheel-rail designs which are now in revenue service (at speeds up to 186 mph (300 km/hr) without excessive vehicle or track maintenance) and which have been tested to 320 mph (515 km/hr).

I would like to close by noting that the professional engineering community, represented by organizations such as ASME, with its broad mechanical engineering expertise and comprised of members from industry, academia, government, and foreign countries can serve as qualified unbiased advisors to the Congress and to the federal agencies responsible for overseeing the development of surface transportation technologies. We stand ready to serve in this role.

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APPENDIX A

MEMBERS OF THE TASK FORCE ON R&D SURFACE TRANSPORTATION

Dr. Steven E. Shladover
PATH Technical Director
University of California
Berkeley, CA

Professor E. H. Law
Department of Mechanical Engineering
Clemson University
Clemson, SC

Professor Robert Stengel
Department of Mechanical And Aerospace
Engineering
Princeton University
Princeton, NJ

Professor Francis C. Moon
Director of the School of Mechanical and
Aerospace Engineering
Cornell University
Ithaca, NY

Mr. Louis T. Cerny
Executive Director
American Railway Engineering Association
Washington, D.C.

Mr. Clarence Hermann
Vice President
Product Engineering
Michelin Technical Services, Inc.
Greenville, SC

Dr. Xunmao Xia
General Tire
Akron, OH

Professor John J. Moskwa
Department of Mechanical Engineering
University of Wisconsin
Madison, WI

Professor Dan Cho
Department of Mechanical and Aerospace
Engineering
Princeton University
Princeton, NJ

Professor Enoch J. Durbin
Department of Mechanical and Aerospace
Engineering
Princeton University
Princeton, NJ

Mr. Paul Fancher
Engineering Research Division
University of Michigan Transportation
Research Institute
Ann Arbor, MI

Mr. James D. Gardner
Bridgestone/Firestone, Inc.
Akron, OH

Dr. C. Shapley
New Hampshire

Mr. D. Rossini
Technical Medical Forensic Consultants, Inc.
West Hempstead, NY

Dr. Saied Taheri
Ford Motor Company
Dearborn, MI

Mr. Phiiip Horton
General Motors Technical Center
Warren, MI

Mr. M. E. Botkin
General Motors Research Laboratories
Warren, MI

Dr. T. B. Khalil
General Motors Research Laboratories
Warren, MI

Mr. James H. Rillings
General Motors Research Laboratories
Warren, MI

Mr. James L. Kasprzak
Maremont Corporation
Carol Stream, IL

Mr. John C. Hallinan
Washington, IL

Mr. VALENTINE. Thank you, Dr. Shladover
Mr. Haack?

STATEMENT OF ALAN H. HAACK, CHAIRMAN, TRANSPORTATION POLICY COMMITTEE, PORT AUTHORITY OF NEW YORK - NEW JERSEY

Mr. HAACK. Good morning, Mr. Chairman, and members of the committee. My name is Alan Haack, and I am a fellow of the American Society of Civil Engineers and am offering testimony this morning on behalf of the American Society of Civil Engineers concerning high-speed rail transportation, magnetically levitated transportation systems, and highway structures and paving materials.

My formal testimony that has been submitted deals with each of the subjects in relationship to research and development efforts to ensure that our nation remains competitive in the world arena of transportation issues.

Relative to highway paving and structures, my prime recommendation is that research be focused on life cycle concerns. Although our country has made great strides in constructing a vast roadway network, the current condition of our infrastructure raises questions on our ability to maintain that which we have constructed.

Maintenance is not popular. It is costly and it usually causes delays. And I would be the first to admit that it is the first item that is deferred when we look at budget crunches.

As we construct new highways or reconstruct our existing highways, our construction methods and materials should provide the greatest length of life and minimize maintenance.

On the subject of high-speed rail and maglev system, I feel it is important that we treat both subjects together, perhaps maglev as a subset of high-speed rail. Our objective should be to have a high-speed, inter-city, surface transportation system that will offer reliable service, particularly to those city pairs in the 200- to 500-mile range. Where rail corridors exist, we should be looking at utilizing existing right-of-ways with dedicated, high-speed rail beds.

We do have high-speed transportation in the rail mode in the metroliner, which I took this morning, which was subject to quite a delay because of traveling on a non-dedicated rail bed with an antiquated signal system. The vehicle, itself, was capable of rather high speeds, but it didn't get to Washington on time because of other congestion en route.

As an alternative to that type of system, we could suggest elevated guideways and maglev system offer us a great potential if constructed within the right-of-ways of our interstate highway system.

I would suggest that future research and development emphasize a consistent approach to high-speed surface transportation that carefully examines not only the vehicle and the propulsion system, but the track and guideway necessary—and I add this morning the signal system, the right-of-way, and the future operations and maintenance of that high-speed system.

I want to offer my thanks to the committee for giving me the opportunity to appear before you today and am anxious to respond to any questions.

[The prepared statement of Mr. Haack follows:]

AMERICAN SOCIETY OF
CIVIL ENGINEERS

Washington Office
1015 15th Street, N.W., Suite 600
Washington, D.C. 20005
(202) 789-2200

STATEMENT OF

ALLAN H. HAACK

CHAIRMAN

NATIONAL TRANSPORTATION POLICY COMMITTEE

OF THE

AMERICAN SOCIETY OF CIVIL ENGINEERS

BEFORE THE

SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

OF

THE COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

APRIL 16, 1991

Executive Summary

As Chairman of the National Transportation Policy Committee and a Fellow of the American Society of Civil Engineers, I represent a large portion of the Nation's transportation professionals. I appreciate the opportunity to testify today on behalf of the civil engineering profession and specifically, those engaged in surface transportation engineering. We want to thank you for holding these hearings.

The issues of research and development progress, problems and objectives pertaining to surface transportation technology are of great interest to the American Society of Civil Engineers and is of paramount importance in the mobility of this country moving into the 21st century.

As requested by the Chairman, my formal testimony, attached herewith, will specifically deal with high speed rail and magnetically levitated transportation systems and research needs in the areas of highway pavements and structures. As you will note in my formal testimony, it is felt that high speed transportation should be examined by taking a total system approach that not only includes the vehicle and the propulsion system, but also carefully examines the environment in which these systems would operate, and how they would operate while competing for resources with other modes of transportation.

In the area of highway pavements and structures research, it is my view that we must look at the life cycle of what we create today in order to avoid future major maintenance, reconstruction and inconvenience to the travelling public.

MAG LEV AND HIGH SPEED RAIL

The American Society of Civil Engineers estimates that there is a substantial demand for growth in high speed intercity transportation. The airline industry, the interstate and primary highway network, and Amtrak are seeing continuous traffic increases. With ever increasing population and the economic capability and desire to travel, intercity travel can be expected to double in the foreseeable future. In the aviation industry, this "doubling" will be realized by the turn of the century or shortly thereafter. Growth in surface transportation -- highways and conventional rail -- will be limited by regulated safety speed restrictions. High speed surface transportation can be a safety value to offer some relief to airport congestion by reducing short-to-medium distance air travel and improving capacity.

In responding to your invitation to discuss research and development in Mag Lev and High Speed Rail transportation, I believe that the two transportation forms can best be treated as one. High Speed Rail is an incremental evolution of conventional railroad technology, while Mag Lev is a newer technology. But both have similar speed and service capabilities. The Amtrak Metroliner service between Washington, D.C, and New York travels at speeds of up to 120 mph and is an example of high speed rail. In Japan, the "bullet trains" travel up to 150 miles per hour (very high speed rail). In France, the TGV's have been clocked at over 300 miles per

hour, but normal operating speeds are more on the order of 185 miles per hour.

Mag Lev can theoretically operate over 300 mph (ultra high speed rail) and tracked vehicles (TGV) have been clocked at over 300 mph, but in the range of 300 mph serious aerodynamic problems occur and will probably be a severe impediment to operations in that range.

While the Japanese "bullet trains" and French TGV's are often characterized as "new technology", they really represent an evolution of existing technologies to a very advanced state, as I have said. In the TGV every component of equipment has been redesigned from the conventional rail. With the redesign of components comes a capability that permits high speeds that would not have been judged imaginable just one or two decades ago. I should mention that very high speed rail is not confined to Japan and France. Germany, Italy and Sweden are also working on their own versions of these advanced technologies.

Mag Lev itself can either be low speed or high speed. Higher speed applications are generally discussed. In America such applications are being considered for the corridor stretching from Las Vegas into Palmdale and other parts of the Los Angeles metropolitan area. In Florida, Mag Lev had been under consideration for a high speed network. The state-wide network when developed

will probably be an advanced version of existing rail technology. However, Mag Lev low speed is still under consideration for a short route segment from Orlando Airport to the International Drive commercial area near Disney World.

Since magnetic levitation is a new science, there continues to be serious technological challenges for Mag Lev including the specific propulsion system and possible health hazards from magnetic fields generated by the linear induction power system. There are also problems with security, requiring elimination of not only people and animals, but debris from the rights of way. The fact that a railroad train can run unimpeded over an automobile tire thrown on the right of way is not at all paralleled in Mag Lev operations. Because of the security concerns, some interests are proposing that Mag Lev trackage be provided in tunnels or in elevated tubes.

In considering the incremental technological advance in very high speed rail and the newer technologies of Mag Lev, I am convinced that we do have the American know-how to meet our challenges and overcome all problems. However, since the U.S. has not actively pursued high speed surface transportation research and development in an intensive way in the past four decades, the biggest challenge facing us is whether we can overcome our institutional inertia and gear our industry and public/private partnerships into building and operating such a system. Government

support has traditionally been used for research. Germany has invested around 1 billion dollars in Mag Lev. Japan is planning to spend 3 billion dollars over the next decade on Mag Lev building and testing. The U.S. has made only minimal investments in high speed ground transportation.

If the U.S. is up to meeting the institutional problems of overcoming inertia and providing adequate "trigger" funding, several key areas of research must be focused on:

1. Very high speed rail and Mag Lev cannot co-exist with conventional rail with the possible exception of slower speed operating zones in built up urban areas. Realization of the true speed potential is possible only with the development of special rights of way. These rights of way will have long radii, exceeding anything that we are already familiar with on conventional rail. Acquisition of new rights of way to support these requirements could be prohibitively expensive particularly in the U.S. where we do not have strict land use controls.

2. Can the special rights of way be built along existing railroad or highway rights of way? This is a specific area of applied research that can and should be addressed.

Focusing first on existing railroad lines, excavation of part of the right of way to support new overhead structures for very high speed rail would disrupt existing passenger and freight operations and could pose safety hazards because of the possibility of toxic materials accumulated over the years in and under the railroad right of way. Where existing railroad lines would be used for elevated high speed service structures, the structures would extend well beyond the existing right of way at curves.

Interstate highways have been gaining interest among high speed rail advocates because of the broad curves that already exist and the widths of the right of way. A 6-lane divided highway built to interstate standards occupies a right of way typically 150 feet wide. As a result, this provides the option or indeed the flexibility of utilizing the entire width of the right of way to provide the needed width for high speed rail radii.

With the Interstate highway programs now drawing to a close, there are many options for making yet better use of these rights of way in the future. These include adding more lanes where appropriate, developing "smart vehicle" lanes and building new structures for high speed rail (including Mag Lev) over the right of way. The downside,

of course, for a plan such as this is the visual pollution and noise attendant with high speed rail operations. Certainly any vehicle moving at 200 mph or more, even though "floating" as in Mag Lev, produces aerodynamic noise. That noise may or may not be more tolerable than very high speed rail of the conventional type. This would be an important area of research.

In addition, if Mag Lev vehicles are built to conform more to aircraft technology rather than railroad technology, the structures could be lighter and to some degree smaller than for conventional rail. This suggests two additional areas of research:

1. What will the equipment safety requirements for Mag Lev vehicles be? And

2. Will those safety requirements be different enough then for conventional rail to have an appreciable impact on the strength and size of the structural components. If indeed it does, then Mag Lev might possess an additional capability of lower costs. With lower costs come a greater opportunity for financial feasibility of this mode.

Let me begin to summarize some of the key points that will impact our thinking as we contemplate the role of high speed rail

technology (including Mag Lev) for intercity passenger transportation in the future:

1. Shared rights of way with existing railroad lines would be considered only in central city terminal areas. Beyond that, the fast trains would require their own structures. If the structure should be built above existing rail lines, the wide radii required to permit very high speed operations would result in the new structure extending beyond existing right of way limits at curves. This would involve land acquisition.

2. If these new high speed rail/Mag Lev structures were to be built above interstate highways, chances are that little additional right of way acquisition would be required.

3. The community at large would have to decide whether the potential high speeds offered by these surface transportation technologies would offset the attendant noise and visual pollution, as well as possible health hazards in connection with the Mag Lev operation.

Accordingly, research funding should address right of way requirements, cost and environmental impacts. In the case of Mag Lev, specifically, the health hazards, if any, caused by the

magnetic fields would have to be researched to complete public satisfaction.

4. The control systems needed for high speed rail operations are not the control systems that we see on conventional rail lines. We can learn from the Europeans and the Japanese in these areas, but we are talking about development of again evolutionary or new technologies to safely control the performance of these vehicles.

5. Once again, it is essential that the safety requirements for high speed ground transportation vehicles be thoroughly investigated. If conventional railroad standards are adhered to, as is the case in evolving or incremental advancements of conventional rail technology, the equipment will be heavy, the structures will be large and the cost will be high. If research proves that lighter-weight technology is indeed, an acceptable alternative for vehicles operating on guideways, then we can expect cost reductions (relatively speaking) and possibly more attractive structures.

6. Labor is yet another element of major consideration in the operation of these newer systems. Will the systems be bound to agreements that parallel existing railroad contracts or can cost-saving manning resource procedures

be established that, perhaps, could attract more traffic through lower fare and ultimately provide more genuine economic advantages for the American work force?

7. Going back to the idea of rights of way, let me add that I believe all abandoned rights of way should be maintained as is until their appropriate future disposition can be carefully evaluated. As to their possible suitability for high speed surface transportation, these abandoned lines are not generally situated in or near major travel markets. In general, they are too narrow to develop the width requirements that the wide radii of the high speed surface transportation services require. In addition, some, of course, are being integrated into parklands, and the compatibility of high speed structures and parklands is questionable on a broad scale.

I propose that the federal government play the all-important role of galvanizing American industry and the financial sector to produce the systems needed to operate these services. If, indeed, we can overcome traditional institutional barriers, the United States will have made a major move towards the development of high speed surface transportation. Once developed, the United States technology base would enhance America's technological competitiveness and certainly improve our balance of trade. As we consider <u>what</u> can be done and <u>how</u> it can be done, we must remember

that there are a series of very important technical issues that must be fully explored and resolved. Research funding is all important here and the funding should be authorized for the entire system, the series of integrated equipment, right of way and service components that ultimately will have to be considered as a unified system.

The problems are daunting; the rewards could be substantial; but in facing up to the problems, let me remind you that, as in so many other technologies that are now located "off shore," the Mag Lev technologies were originally developed here in America at the Brookhaven National Laboratories on Long Island. Creative thinking has moved America far, and that type of thinking will be necessary for us to excel in the successful development and implementation of high speed surface transportation.

HIGHWAY PAVEMENTS AND STRUCTURES

Given the current state of the economy and, not least of all, the environment, there has been a need to focus on the rebuilding of our existing infrastructure with an eye toward maximizing investment and extending the life span. Our civil infrastructure of local roadways, highways, runways, parking lots, bridges, etc., although durable are becoming more and more in need of repair due to excessive loading, wear, environmental factors and simple aging.

When traffic loads and volume exceed the level for which these pavement structures were designed, there are significant problems. Asphalt surfaces, for example, crack, rut, pothole, spall and wear. As one of the most common paving materials used, it does not always stand up to traffic the way we would like it to and is not suitable under temperatures above 90· for durations of several days in a row.

Concrete pavements crack, fault, wear, polish and have joint problems. While concrete is a preferred method of paving in terms of durability and service life, it does specifically exhibit failings when exposed to de-icing salts and chemicals and, most importantly, repairs in concrete requiring long curing times during which vehicles cannot pass over the surface.

Regardless of surface materials used, deterioration results in rough pavement surfaces that reduce riding comfort and safety and can result in major traffic backups. The ability to improve

pavements' load-bearing capacity and rideability has become one of our primary concerns.

Some explored means to improve asphalt pavement serviceability have been to design better asphalt mixes, modify asphalt binders, add latex binders, use natural occurring additives and work with fiber-reinforced asphalts when highly stabilized pavements are needed.

With portland cement concrete, great strides have been achieved through the use of steel fibers. Steel fiber filled concrete pavements are now used on a regular basis whenever thin, high stress resisting pavements are needed. There is also latex concrete that protects concrete deck structures for longer periods of time than when membranes are used. Some produced latex concretes minimize the need to detour traffic by curing within 48 hours rather than the standard 96 hours.

Although there have been recent tests in which high strength, early cure, polypropylene fiber filled concrete pavement and early cure commercially available proprietary concrete materials were used, the need exists to successfully develop these means as viable and standardized approaches.

As you can see, attempting to improve pavement performance has been an ongoing task. A great deal of time has been spent

investigating how to improve the design of pavement and roadway structures and, yet, there are other concerns which should not be overlooked:

- In an effort to address environmental issues, there have been investigations into the addition of waste products such as glass and rubber to the pavement mix as a means of recycling materials. Unfortunately, a lot of the glassphalt pavement being built today may turn slippery and be a cause for concern.

- Although the impact due to detouring traffic has been addressed through the use of innovative technology, the need continues to exist for us to find ways to diminish downtime associated with repairs, as we attempt to rebuild our pavements and roadways.

Our experience in rebuilding roadways has given us valuable information regarding what is possible and what still needs to be addressed.

Mr. Chairman, thank you again for the opportunity to appear before you today. I will be happy to answer any questions from the Committee.

Resume

ALLAN H. HAACK

Allan H. Haack has been a member of the American Society of Civil Engineers for over 35 years and currently holds the membership grade of "Fellow". Over the years, Mr. Haack has served the American Society of Civil Engineers as Chair of the Airport Landside Committee, Executive Chairman of the Air Transportation Division, and currently the Chair of the National Transportation Policy Committee.

Mr. Haack has been employed by The Port Authority of New York & New Jersey since 1956 and has advanced through a series of senior positions in the Engineering, Terminals and Aviation Departments which includes that of Assistant General Manager, John F. Kennedy International Airport, and in his current position as General Manager/Chief, Aviation Planning Division.

Mr. Haack is a graduate of Duke University and has completed graduate study in Engineering Management at C.W. Post University. Mr. Haack also holds a Professional Engineering License and served as an Engineering Officer in the U.S. Marine Corps achieving the rank of Captain. He is also a member of the American Association of Airport Executives and the Wing's Club of New York City.

Mr. Haack is an annual guest lecturer in Airport Design, Planning, Construction and Operation at Oxford University in the U.K. and recently became the first U.S. member of the International Civil Airport Association European Planning Group.

Mr. Haack lives in Rockville Centre, Long Island. His wife Edith is the Headmaster of Grace Day School, a private school in Massapequa, and they have two married daughters and two grandsons.

Mr. VALENTINE. Thank you, Mr. Haack.
Mr. French?

STATEMENT OF ROBERT FRENCH, ROBERT L. FRENCH & ASSOCIATES, FORT WORTH, TEXAS

Mr. FRENCH. Mr. Chairman and members of the committee, my name is Robert L. French. I'm a physicist and I have been involved in intelligent vehicle highway systems, or IVHS, since 1969. My present consulting practice is devoted entirely to the field of IVHS—has been since 1985. As an adjunct to my consulting practice, I publish "The Intelligent Highway," an international newsletter on IVHS, which is the first of its type.

I'm here to testify concerning IVHS as a result of being suggested by the Institute of Electrical and Electronic Engineers; however, I am testifying on my own behalf rather as a representative of the IEEE or of any of the other professional societies with IVHS interests that I also belong to. Nor am I here as a representative of any of my domestic or international clients.

You have already heard from others about the nature of IVHS and the benefits it can bring in helping maintain the mobility necessary for a productive and competitive society. I'm sure that you have also heard about the IVHS potential for improving traffic safety, conserving energy, and reducing environmental degradation.

Rather than speak further on those topics, I'd like to offer some observations and thoughts on how different types of organizations are responding to IVHS. I believe that a better understanding of how different types of organizations are responding can possibly help with public and strategic decisions concerning the new opportunities and challenges of IVHS.

I hope this testimony will also support the point that enabling legislation is urgently needed in order to sustain the present momentum that has been built up for a National IVHS program as a result of, I think, perhaps unprecedented cooperation among the different sectors involved— government, industry, and academia.

Here are some examples of organizational responses, starting with those of a few professional societies such as the IEEE:

In 1989, the Vehicular Technology Society of the IEEE sponsored VNIS'89, the first major technical conference held in North America on IVHS topics. VNIS, which stands for Vehicle Navigation Information Systems, has since become a regular conference series. In addition, the Vehicular Technology Society of the IEEE recently produced a special issue on IVHS for the February 1991 issue of IEEE Transactions on Vehicle Technology.

Next month IEEE Spectrum, which is the principal, flagship publication of the IEEE—goes to all 300,000 members—will have its cover article featuring IVHS.

Another society, the SAE—Society of Automotive Engineers—back in 1985 formed the first committee to start efforts towards standards for automobile navigation systems. Last year the SAE joined with the IEEE and proposed a joint secretariat to more broadly pursue IVHS standards.

In addition, both the SAE and IEEE have sponsored occasional short courses on IVHS since 1988.

Another organization that has come forward very strongly on IVHS is the Institute of Transportation Engineers, or ITE. Last year the ITE formed an advisory committee on IVHS to help formulate its response. Its major objective is to help its members prepare for effectively utilizing IVHS in the future. One step already taken by the ITE was the dedication of the entire November 1990 issue of the ITE Journal to IVHS topics.

Finally, to mention briefly that the American Society of Civil Engineers started a new series of international conferences in 1989 to deal with IVHS and other advanced technologies in transportation engineering.

A number of other societies are already beginning to include one or more sessions on IVHS in many of their conferences. It does cut into the territory of many, many different technical and professional groups.

I think the main message signaled by the responses of these professional organizations that IVHS—is that they perceive it as real, as worthwhile, and as imminent.

The common trend among the responses to IVHS by public organizations, private, academic institutions is the formation of consortia and alliances. An outstanding example is Mobility 2000, the informal alliance that did so much to define and coordinate IVHS activities before its role was recently subsumed by IVHS America.

IVHS America, itself, is a formal alliance to coordinate the efforts of government bodies, industry, and the academic community, to serve as an advisory committee to the Department of Transportation and to be the principal interface for international cooperation.

With that area I will move on simply by noting that virtually all of the field tests, trials, evaluations of IVHS going on right now in the U.S. such as Pathfinder, TravTek, the Help project, etc.—most of which you have heard about already—are, indeed, cooperative ventures involving such consortia—alliances—between various combinations of public and private organizations. Similar patterns of joint activity are also observed in the response of European and Japanese organizations in pursuing IVHS in their countries.

The final type of organizational responses that I will mention very briefly are those of foreign organizations. Since 1986 I have been retained by several Japanese and European organizations to keep them advised on IVHS developments in the United States, as well as elsewhere outside their own regions.

During this period important IVHS programs evolved abroad such as PROMETHEUS and DRIVE in Europe, AMTICS and RACS in Japan. For several years, contact and information exchange between these programs and similar interests in the United States was hindered, among things, by the absence of a properly-constituted body to represent U.S. interests internationally in IVHS. Of course, IVHS America now fulfills that role.

Japan's response to the formation of IVHS America was to establish the Liaison Council for IVHS/RTI Japan in order to carry out futher information exchange both inside and outside Japan. The European programs have responded by sending top level represent-

atives to all significant activities of IVHS America starting with its inception last May.

These enhanced levels of international exchange and cooperation should contribute to more efficient IVHS research without needless duplication of effort. The exchange is beginning to be reinforced by direct participation of foreign businesses in some U.S. IVHS projects, thus putting some U.S. firms at risk for not responding more quickly and aggressively to IVHS opportunities. What is needed for U.S. firms to respond more aggressively and completely? I think one thing is the assurance that it will be an ongoing program— assurance of a multi-year program.

In summary, I'd like to point out that although most of the IVHS concepts date back two or more decades, remarkable progress has been made only in the last three or four years toward establishing the unified national program that is needed to bring IVHS to fruition. With IVHS America now in place, the next major requirement is legislation to establish a multi-year program. Such a program will provide the continuity needed to encourage a wide range of private as well as public organizations to apply their own resources in developing various aspects of IVHS.

Thank you, Mr. Chairman.

I'd be pleased to answer any questions you may have concerning my views on IVHS.

[The prepared statement of Mr. French follows:]

STATEMENT OF
ROBERT L. FRENCH
IVHS CONSULTANT

BEFORE THE
U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

CONCERNING
INTELLIGENT VEHICLE HIGHWAY SYSTEMS

APRIL 16, 1991

Mr. Chairman and Members of the Committee:

My name is Robert L. French, and I am a physicist with an independent consulting practice under the business name R. L. French & Associates. I have been involved with intelligent vehicle highway systems, now commonly called IVHS, since 1969. My present consulting practice has been devoted entirely to the field of IVHS since 1985.

The major elements of IVHS are advanced traffic control, communication networks, smart cars, and vehicular automation. Although I consult across the board in IVHS, my original specialty is automobile navigation and route guidance. I am the inventor of map matching, a software technology now used worldwide to help smart cars keep track of their location.

I'm here to testify concerning IVHS as the result of being suggested by the Institute of Electrical and Electronic

Engineers. However, I am testifying on my own behalf rather than as a representative of the IEEE or any of the other professional societies with IVHS interests that I also belong to. Nor am I here as a representative of any of my domestic or foreign clients.

You've already heard from others about the nature of IVHS and the benefits it can bring in helping maintain the mobility necessary for a productive and competitive society. I'm sure that you have also heard about IVHS' potential for improving traffic safety, conserving energy, and reducing environmental degradation.

As an alternative to topics you've already heard, I'd like to offer observations and thoughts on how different types of organizations are responding to IVHS. I've experienced many examples from the perspective of a consultant having contacts involving IVHS with a worldwide variety of organizations and clients. In addition, I am aware of additional organizational responses to IVHS through recent collaboration with Professor Kan Chen of the University of Michigan on a paper we are preparing on organizational responses. By the way, Professor Chen coined the term "IVHS" in 1988.

We believe that a better understanding of how different

organizations are responding to IVHS can help with public and strategic policy decisions regarding the new opportunities and challenges of IVHS. I hope that this testimony will also help support the point that enabling legislation is urgently needed to sustain the present momentum toward a national IVHS program that has been recently achieved as a result of virtually unprecedented cooperation among government, industry, and academia.

Some background information will provide context for my perspective.

In 1969, the Bureau of Public Roads' was pursuing its soon-to-be aborted research on ERGS, an infrastructure-supported electronic route guidance system that was one of the first IVHS undertakings in the world. ERGS research centered on the smart highway aspect of IVHS, and used a form of roadside beacon to communicate traffic-dependent routing instructions to passing cars equipped with relatively dumb systems.

Also in 1969, I started a minicomputer systems integration firm and focused on new applications of computers installed in commercial vehicles. In order to meet the high vehicle location accuracy requirements of one client who wanted to automate the home delivery of newspapers, I invented map

matching. Map matching is an artificial intelligence software technology that reconciles measured vehicle path with a digital road map to maintain precise knowledge of location.

Map matching was first used in 1971 by the automatic route control system, or ARCS, to automate the home delivery of newspapers. This required that ARCS signal for a newspaper to be tossed as passing each subscriber's house while also issuing real-time route instructions to the driver. Route instructions were by means of simple panel displays and pre-recorded voice messages.

ARCS and ERGS set the pattern for subsequent IVHS work in Japan and Europe as well as the United States, and almost all current systems use refinements of these early approaches. Map matching is used almost universally in navigation and route guidance systems for smart cars, and route guidance is given primarily by simplified displays and synthesized or digitized voice. Although several alternative communication technologies are being considered, roadside communications beacons continue be a popular concept, especially outside the United States.

The main points from this background are that the concepts

and major technologies for IVHS have been around for decades, and that many of the key technologies were pioneered in the U.S. Thus, rather than the technological aspects, the challenge in exploiting the potential benefits of IVHS lies largely in the organizational aspects because IVHS cuts across so many business and institutional sectors, producing different types of responses among them.

Here are some examples of organizational responses, starting with those of professional societies such as the IEEE.

In 1989, the Vehicular Technology Society of the IEEE sponsored VNIS'89, the first major technical conference held in North America on IVHS topics. VNIS, which stands for Vehicle Navigation and Information Systems, has since become a regular conference series. The next VNIS will be held in Dearborn this fall, and others are planned for 1992 in Oslo, 1993 in Canada, and for 1994 tentatively in Tokyo. In addition, the Vehicular Technology Society produced a special issue on IVHS for the February 1991 *IEEE Transactions on Vehicular Technology*. Next month, *IEEE Spectrum*, the IEEE's flagship publication that goes to all 300,000 members, will feature IVHS in its cover article.

The Society of Automotive Engineers, or SAE, formed a

committee in 1985 to start efforts toward standards for automobile navigation systems. Last year, the SAE joined with the IEEE to propose a joint secretariat to facilitate IVHS standards development. Earlier this year, SAE leaders and staff met in Detroit to map out plans and organizational changes for an even more comprehensive and proactive role in IVHS. In addition, both the SAE and the IEEE have sponsored occasional short courses on IVHS since 1988.

The Institute of Transportation Engineers, or ITE, formed an Advisory Committee on IVHS in 1990 to help formulate its response to IVHS. A major objective of the ITE is to help its members, who are primarily practitioners rather than researchers, in preparing for effectively utilizing IVHS. Committee recommendations have been accepted, and several initiatives are underway to serve member needs concerning IVHS. One step already taken by the ITE was the dedication of the entire November 1990 issue of the *ITE Journal* to IVHS topics.

The American Society of Civil Engineers started a new series of international conferences in 1989 to deal with IVHS and other advanced technologies in transportation engineering. In addition, other technical societies covering one or more of the many disciplines incorporated in IVHS now typically

include a few sessions on IVHS at their conferences.

The main message signalled by these professional society responses is that IVHS is perceived as real, worthwhile, and imminent.

A common trend among the responses to IVHS by public, private, and academic institutions is the formation of consortia and alliances. An outstanding example is Mobility 2000, the informal alliance that did so much to define and coordinate IVHS activities before its role was recently subsumed by IVHS AMERICA. IVHS AMERICA itself is a formal alliance to coordinate the efforts of government bodies, industry and the academic community, to serve as an advisory committee to the Department of Transportation, and to be the principal interface for international cooperation.

Virtually all of the present IVHS evaluation and field trial projects such as Pathfinder and TravTek are cooperative ventures involving public and private participants. Such approaches are necessary because of the multidisciplinary nature of IVHS, and because individual organizations seldom have sufficiently complete jurisdiction over an IVHS test area. Similar patterns of joint activity are also observed in the responses of European and Japanese organizations in

their pursuit of IVHS.

By and large, the responses of public sector transportation agencies to IVHS has been stronger than that of most private businesses. The responses of even those U.S. companies that stand to do substantial amounts of business in IVHS tend to be slowed in part because future returns are viewed as too remote to justify immediate investment. Another deterrent for private industry has been the uncertainty about when and how public sector agencies will move toward providing the supporting infrastructure required by IVHS. Although the existence of IVHS AMERICA and the stepped-up IVHS activities of public sector agencies are helping attract more and more business interest, the strongest industry responses will probably come only after a multi-year IVHS program is assured by legislation.

The final types of organizational responses that I will outline here are those of foreign organizations. I am keenly aware of these responses because over one half of my IVHS consulting business comes from outside the United States.

Since 1986, I've been retained by several Japanese and European organizations to keep them advised on IVHS developments in the United States as well as elsewhere

outside their own regions. During this period, important IVHS programs evolved such as PROMETHEUS and DRIVE in Europe, and RACS and AMTICS in Japan. For several years, contact and information exchange between these programs and similar interests in the United States was hindered by, among other things, the absence of a properly constituted body to represent U.S. IVHS interests internationally. IVHS AMERICA now fulfills that role.

Japan's response to the formation of IVHS AMERICA was to establish the Liaison Council for IVHS/RTI Japan in order to carry out information exchange both inside and outside Japan. The European programs have responded by sending top level representatives to all significant IVHS AMERICA meetings starting with its inception last May.

These enhanced levels of international exchange and cooperation should contribute to more efficient IVHS research without needless duplication of effort. The exchange is beginning to be reinforced by direct participation of foreign businesses in some U.S. projects, thus putting some U.S. firms at risk for not responding quickly and aggressively to IVHS opportunities.

In summary, I would like to point out that, although most

IVHS concepts date back two or more decades, remarkable progress has been made only in the last three years toward establishing the unified national program that is needed to bring IVHS to fruition. With IVHS AMERICA now in place, the next major requirement is legislation to establish a multi-year program. Such a program will assure the continuity needed to encourage a wide range of private as well a public organizations to apply their own resources in developing various aspects of IVHS.

Thank you, Mr. Chairman. I would be pleased to answer any questions you may have concerning my views on IVHS.

Mr. VALENTINE. Thank you, Mr. French.

Dr. Shladover, how would you compare maglev to high-speed rail in terms of passenger convenience and economics?

Dr. SHLADOVER. Our task force did not really attempt to direct comparison between those two modes. We had separate people on the task force who were expert in high-speed rail and expert in maglev, but we did not attempt to make a direct comparison between them.

Each of the modes has its advocates who can cite a lot of statistics, but we have not yet seen a thorough, comprehensive evaluation that compares them directly.

Mr. VALENTINE. On this magnetic levitation technology, you seem in your statement to speak to that question in your official capacity. Do you have a personal opinion which you would care to share with us?

Dr. SHLADOVER. I have a personal opinion based on the level of development of the technology in the other countries that have been working on it and the investment that has been devoted to it in those countries compared to the investment in this country, which indicates that this country has quite a lot of ground to make up.

The potential balance of payments implications may not be that significant given the amount of investment that would go into vehicles as compared to guideways if the guideways would be constructed here anyway out of domestic content. That is purely a personal opinion.

Mr. VALENTINE. I would like to get you to give us a little more detail, if you would, as to your opinion of the stability of these trucks with two or three trailers as compared to trucks with one trailer, because this is a matter of some real serious concern to me. I can understand perhaps some serious discussion on allowing double trailers on the highways in parts of the country where the roads are straight for hundreds of miles, but it seems to me that discussion about allowing double or triple trailers on the highways in the eastern part of the United States is like debating the question as to whether or not we should raise the speed limit to 150 miles an hour. What do you say about that?

Dr. SHLADOVER. We, representing the ASME Task Force here, are not actually the experts on that subject. We would have to refer a more-detailed question to the members of the task force who are the experts on those subjects. We could try to get an answer back to you from the task force members who have the specific expertise in that area.

[The information to be supplied follows:]

The American Society of Mechanical Engineers

Suite 218
1825 K Street, N.W.
Washington, DC 20006-1202
202-785-3756

May 23, 1991

Sherri Stone
Subcommittee on Technology and Competitiveness
Committee on Science, Space and Technology
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Sherri:

The enclosed document is submitted for inclusion in the record of the Subcommittee's April 16, 1991 hearing on surface transportation. It responds to Chairman Valentine's question to our witness, Dr. Shladover (see page 25 of the hearing transcript). The response was prepared by Mr. Paul Fancher, a member of the ASME Task Force that prepared our testimony. Mr. Fancher is located at the University of Michigan, Transportation Research Institute, 2901 Baxter Road, Ann Arbor, MI 48109-2150.

The views expressed in this document are those of Mr. Fancher, an expert in the field, and are not an official position of the ASME.

Should you require any additional information, please let me know.

Sincerely,

Nelson L. Milder
Assistant Director
Policy Development and Technical Support
Government Relations

Received 6-3-91

Comments on the Stability of Trucks with Two or Three Trailers

These comments are in response to Mr. Valentine's question:

> "I would like to get you to give us a little more detail, if you would, as to your opinion of the stability of these trucks with one trailer, because this is a matter of some real serious concern to me. I can understand perhaps some serious discussion on allowing double trailers on the highways in parts of the country where the roads are straight for hundreds of miles, but it seems to me that discussion about allowing double or triple trailers on the highways in the eastern part of the United States is like debating the question as to whether or not we should raise the speed limit to 150 miles an hour. What do you say about that?"

In order to respond to the question, I have asked myself a series of related questions.

1. Would allowing doubles and triples be as unsafe as allowing all vehicles to travel at 150 mph?

I do not think so, nor do I think that the two subjects are of the same order of magnitude with regard to safety consequences. The vehicles and roads are not designed in the U.S. (East or West) to be used at 150 mph. Drivers do not have experience at operating at these speeds and normal human response times and diligence at performing the driving task may not be satisfactory for driving at 150 mph. Perhaps someday with the introduction of automatic controls we will have vehicles that can travel safely at highway speeds with very little headway in specially designated lanes. Although this possibility may come sooner than many of us anticipate (if Intelligent Vehicle Highway System (IVHS) technology progresses rapidly), it seems pointless to consider raising speed limits now. (Even so, some people may envision the day when they can travel in their cars from Detroit to D.C. at 150 mph.)

On the other hand, a number of states (particularly in the Western U.S.) have permitted doubles and triples. The interstate roads in the East are for the most part built to the same standards as those in the West. Given that doubles and triples were to be allowed under a permit system, there could be control over the types of roads they would be allowed to use. Furthermore, the permit system could require that the properties of the allowed vehicles be compatible with the roads. Perhaps this would require roadway modifications and provisions to refurbish and rehabilitate or upgrade bridges in some cases, but this would be nothing like the modifications needed to provide roads with 150 mph design speeds. Since these multi-trailer vehicles have been operated (albeit under carefully controlled conditions) with an excellent safety record, there is evidence that experienced drivers can control them and compensate for their operating characteristics.

There are those that object to this record because it is presented by persons with a vested interest. Nevertheless, the point is that there is something to talk about with regard to doubles and triples. The vehicle, roads and drivers are here now. There is something to debate. It seems reasonable to ask if this is the way to go. Will the productivity benefits improve the quality of life and aid in keeping the U.S. competitive as new technology develops throughout the world?

2. Assuming the doubles and triples were allowed to operate in the East, what safety problems would you anticipate?

First of all please recognize that the answer to this question required a prediction. It is true that doubles have operated on the interstate system throughout the U.S. Apparently, the safety record of the twin 28's has not been so terrible that there is strong evidence to disallow them. Even though there is not extensive information and data to go on, it seems that it is difficult to show that these vehicles cannot be operated successfully.

With regard to triples the picture is less clear. The biggest concern with these vehicles might be their ability to be driven safely in dense, high speed traffic. Certainly they could be difficult to pass on two lane roads, but perhaps they would not be used on those roads.

Multi-trailer trucks can be expected to have the same stability, control, and traffic-obstruction problems as all other trucks; specifically, braking capabilities, roll stability, and acceleration and hill climbing capability need to be considered as they are for tractor semitrailers and straight trucks. In addition to the performance concerns regarding all trucks, multi-trailer trucks also suffer from "rearward amplification" that occurs in obstacle avoidance maneuvers.

The need for obstacle avoidance maneuvers occurs in situations where someone pulls-out or stops abruptly in front of a truck. If there is not enough time to stop, the truck driver can try to move the vehicle to an adjacent lane using a sudden steering action first one way then the other. This type of quick steering can result in exaggerated and violent swaying of the last trailer--rearward amplification.

The need for such sudden and violent action is rare if the driver is diligent, travels at a reasonable speed and headway, and is good at anticipating conflicts. Furthermore, the amplitude of rearward amplification (that is the resulting swaying from side to side of the last trailer) is highly dependent upon forward speed. At low speeds the motions are mild. However the problem can become significant at 50 mph and can increase at higher speeds.

There are counte-measures and design properties that can be used to reduce rearward amplification. The importance of rearward amplification will depend upon the properties of the vehicles allowed. If the allowed vehicles have short trailers and high centers of gravity when laden, the incidence of rearward-amplification-related accidents may become much more frequent than it is now. On the other hand, if the trailers are long, the centers of gravity are low, the units are equipped with "stiff" tires (such as modern radials are now), and innovative dollies are used for hitching the trailers together, rearward amplification may be a rare event.

The quality of driving is also very important. If triples were allowed in operations that did not involve careful control of the quality of driving, one would anticipate an increase in accidents associated with rearward amplification. It seems important to maintain strict control over driving quality, if large numbers of triples were allowed to operate in the U.S. generally.

3. What is being done to improve truck safety?

The so called "innovative dolly" which controls the steering of dolly wheels is an example of an engineering solution for reducing rearward amplification in multi-trailer vehicles. The use of anti-lock braking systems (ABS) is an example of a countermeasure applicable to all types of trucks including multi-trailer vehicles. Given that these devices improve the performance capabilities of the vehicles, they should improve the ability to avoid accidents if the vehicles are driven prudently.

With regard to longer combination and multi-trailer vehicles, there are research studies underway to develop test procedure for evaluating their roll stability and also their performance in obstacle avoidance maneuvers. If minimum performance levels were part of a vehicle certification system, vehicles with low performance levels could be eliminated. Although the permits developed by trucking organizations do not now include provisions on vehicle performance, federal or state permits could include performance requirements in safety-related situations. In some cases, the current state of knowledge would allow designs to be screened for vehicle combinations that will meet performance requirements.

Presuming that the trucking industry is interested in safety as well as productivity, the technical issue may be reduced to setting appropriate performance levels. To a certain extent, judgment is likely to play a part in setting performance levels. After all, the researchers are trying to predict what will happen as the transportation system changes. From a technical standpoint, the researchers are trying to use objective measures such as stopping performance, roll stability, rearward amplification, etc., to judge the intrinsic safety of various vehicle combinations.

Mr. VALENTINE. Mr. Haack, given your position with the — it's the New York-New Jersey Port Authority isn't it, sir?

Mr. HAACK. That's correct.

Mr. VALENTINE. What technologies do you see as being potentially the most effective in minimizing traffic congestion nationally?

Mr. HAACK. Most effective did you say?

Mr. VALENTINE. Yes, sir.

Mr. HAACK. I have to speak in the area of the New York area where we do have a lot of congestion in the tri-State area. One of the situations that we put together is an organization that reports on traffic difficulties and gets input from all of the municipalities. Since we are a tri- State area, there are all kinds of jurisdictions and all kinds of police agencies and so forth. With the Port Authority as the initial force, we have been able to put together a group of people that takes those reports and puts out live information, advance warnings of construction, analyzes construction, and offers advice to the traveling public during the congested period where they can find congestion and how they can avoid it. I see that as a very practical and effective way of assisting. I don't see—particularly in the New York metropolitan region—more highways being the answer to that problem.

Mr. VALENTINE. What, in your opinion, is the status with respect to whether or not extensive research is necessary to develop these so-called "quick setting" paving materials that reduce the time it takes to repair highways?

Mr. HAACK. I think that's very important. I should have highlighted that very much in my comments and have in my written documentation.

Materials that can replace asphalt that has a very short life cycle—highways that are repaired and repaved with asphalt have a life of six to eight years perhaps, and then you have to remove that or pave on top of it, and each time you repave that same surface you are creating a problem for the next five to seven years. That cycle sometimes shortens with the thicker the asphalt gets.

I'm very much of a proponent of some form of quick- setting concrete material that can be used in paving, not only on highways but in airports, which is also a concern of mine.

Mr. VALENTINE. Is a quick-setting material now available if you can afford it?

Mr. HAACK. There are quick-setting materials, but what is quick is a matter of conjecture. Quick-setting has to be something that could set up in several hours so that you could pave during the day and have a highway or an airport reopened for a rush hour period in the evening. I don't believe those materials are currently available, or perhaps currently available in a price that could be afforded.

Mr. VALENTINE. Mr. French, excessive speed is, of course, a well-known cause of automobile accidents. What electronic countermeasure equipment is available? Or what technologies are needed to prevent interference with police radar equipment? And what research, in your opinion, is needed in this area?

Mr. FRENCH. The area of fuzz busters or radar detectors for detecting—apprehending—speeding vehicles is not an area I have any particular professional knowledge in, or very little experience

in. I have no such devices myself. I would note, however, that one objective of IVHS—some of the longer-term aspects of it—would, indeed, lead to the possibility of higher speeds under safe conditions with assisting information and control devices for the driver. But so far as apprehending conventional speedsters is concerned, I have nothing to contribute in that area.

Mr. VALENTINE. Mr. French, do you believe that any research work should be considered in the area of artificial intelligence and sensing devices that could make the automobile less sensitive to some driver errors? Is that within the realm of possibility?

Mr. FRENCH. Yes, indeed. Progress is being made in that area and it is a very important aspect of IVHS apparatus to monitor driver conditions through the dynamics of the vehicle and various other sensor means to make decisions as to whether the driver is in appropriate control of the vehicle. You are all well aware that drivers who are influenced by things they shouldn't be using, perhaps, as well as older drivers—and we do lose some of our perception there—are perhaps the lowest common denominator out on the streets contributing to safety conditions and—indeed, a great deal of the thrust for IVHS is to provide monitoring systems to help drivers determine whether they should be driving or not, or in some cases perhaps preclude them from driving if they shouldn't be; in other cases, to assist them in driving.

Mr. VALENTINE. Well, there is a veritable gold mine of questions for one who has a concern about some of these contraptions such as fuzz busters, but I have other questions, of course, but we have a lot of members here today and I will come back to them. I want to, of course, afford an opportunity for other members to question the panel, and I will then therefore yield to the distinguished ranking member of the subcommittee, Mr. Lewis, from Florida.

Mr. LEWIS. Thank you, Mr. Chairman.

Mr. Haack, you mentioned in your testimony on page four about the—"Germany has invested $1 billion in maglev and Japan is planning to spend $3 billion in maglev." We only have minimal advancements. How do you feel and how do the professional organizations feel—how do we get competitive with these companies or these countries? What is the first solution to be used?

Mr. HAACK. I think part of it is understanding what maglev is. I think maglev has become a buzz word, and I think we have to look at the whole question of high-speed surface mass transit and put it into the perspective of what we think is really achievable, where we are now—and sometimes we forget that—what competing nations are doing.

I think, for example, TGV in France is often offered as the yardstick to where we are. TGV has a top operating speed just recently of about 180 miles an hour. We do operate in the northeast corridor on the trains between New York and Washington at about 120 miles an hour, so there is a delta in there. I think what we have to become is realistic in improving the speed of our surface transportation, and perhaps maglev is the answer—maglev offers some real possibilities in that—but I don't think it is the only answer. I'm just concerned that maglev has become a magic buzz word, just as STOL aircraft was a decade ago.

Mr. LEWIS. But isn't this also a pattern that we seem to follow where the other countries do the investing in the research? A lot of times we come up with the initial investment and start the movement, and then we just let it go by the wayside and they come forward and spend the money and set the priorities of long-term programming and planning in order to do this? I guess our priorities here are sort of— well, not established like they should be when you take into consideration first dollars cut at the Federal level, the state level, would be the R&D dollar.

My great concern is here, with the Federal Government in deficit, most of the major States in deficit, a slow-down economy, you can't get the banks to loan anybody any money, how can we turn this around in order to get R&D as a number one priority because it is really the future lifeblood of our economy as well as our technology?

Mr. HAACK. It's an interesting question. I think we've done that in the air industry with—I think the United States is clearly a leader there.

I think the American public is in love with their car, and I think we're proposing mass transit systems that really would take people out of their cars, so I'm not really sure that the public is there behind us in the development of those systems, where I think they are behind us in the development of aviation systems because there is a—you can take a person out of their car and put them in an airplane, and the public loves that. But I think there is a romance with the car where these are mass transit systems we're talking about—particularly a maglev system—and I think you first have to break through and get to the American public that this is important to separate the person from their car and have them travel in a mass transportation mode.

Mr. LEWIS. Mr. French, do you care to respond, or Doctor Shladover?

Dr. SHLADOVER. I'd like to make one comment on the similarity between maglev and the high-speed rail. It is important for us to recognize that we don't have a domestic passenger rail car industry in this country any more, and whether we are building a maglev vehicle or a high-speed rail vehicle, vehicle technology has gone away. All of the urban rail vehicles that we install in our cities are imported, whether they are imported from Canada, Europe, or Japan, and if we are to do maglev or high-speed rail, we would have to develop that industrial infrastructure which has vanished over the past decade. So the issues are very similar, whether it is high-speed rail or maglev.

Mr. LEWIS. Mr. French?

Mr. FRENCH. I would simply add that there is an IVHS angle there, as well, and that one purpose of IVHS is to facilitate the exchange among different modes of surface transportation so the person can use perhaps multiple modes during the course of a journey. Whether some segments be maglev or other forms of public transit, railway, or what have you, certainly to get the people into them—to feed them into it—they need information and convenient ways of doing it. This is one of the newer thrusts of IVHS—to provide the information to individuals for taking advantage of alternate forms of transportation.

Mr. LEWIS. A couple of you mentioned in your testimony the concerns with the double-backs or the double-bottom trucks on the highways. More research needs to be done in certain areas. If this is such a critical situation, wouldn't it be smart to disallow the double and triple hauling of these trucks over the highways until we have a better system in order to prevent some of the problems that you are concerned about?

Dr. SHLADOVER. I think I would like to defer to Doctor Law to address that issue.

Dr. LAW. My name is Doctor Harry Law from Clemson University. As I understand it—

Mr. LEWIS. Big orange.

Dr. LAW. Excuse me?

Mr. LEWIS. Big orange.

Dr. LAW. Little orange here today.

As I understand your question, sir, it is whether we should, in fact, ban the multiple trailers from the highways. Until those issues are resolved. The task force does not have statistics on the accident rates of those kinds of vehicles as compared to our standard tractors hauling single trailers; however, the input we have received indicates that there are some serious problems with these kinds of vehicles, particularly in situations when you are changing from going at a constant speed on a straight line—for example, in emergency maneuvering to avoid a collision, in breaking in a turn going on and off exit ramps to highways, those kinds of things. When you are changing speed and changing direction, that's when some of these problems occur that have not occurred or have been dealt with successfully for so-called standard, single-trailer vehicles. According to our task force input, there has been progress made in understanding the phenomena. There also has been progress made in developing solutions for the phenomena. But there does need to be work done on looking at and trying to come up with better hitching mechanisms between the trailers to alleviate these problems, and also in terms of the braking systems for trucks.

Some years ago there was a regulation advocating or essentially insisting on ABS systems for trucks. That ran into some difficulty, as you may know, and now there seems to be a real need for looking at new ABS systems—anti-lock braking systems—for trucks because the stability of these things during braking depends upon avoiding wheel lock. So that's a hot issue that needs to be addressed.

Mr. LEWIS. I have one other question, Mr. Chairman.

I'd like the three of you to comment on the Department of Transportation funds—university transportation centers. I would like for you to respond as to—I wonder if you are familiar with these centers and the type of research they conduct and what are the strengths and weaknesses of that research.

Dr. SHLADOVER. I guess I can start, being in the university. I am at the University of California Berkeley, where one of the regional centers is located. It is a very important part of the academic research program within the university. It provides the opportunity for a center of excellence for people to really develop expertise in solving transportation problems across a wide range of application

areas, so it has become a very important element in the academic research program at the university.

Mr. LEWIS. Mr. Haack or Mr. French, from your professional—

Mr. HAACK. I can't offer any—I'm aware of the program, but I do not deal with it on a regular basis.

Mr. LEWIS. Do you request any research and development specifically from your particular authority?

Mr. HAACK. No. We do our own or contract. I don't think we have used the center yet at New York.

Mr. LEWIS. Thank you, Mr. Chairman. My time is up.

Thank you, gentlemen.

Mr. VALENTINE. Thank you, Mr. Lewis.

Just one second before I yield to Mr. Roemer. This question about—perhaps to Doctor Law—has to do with the trailers. You can just stay seated there. I think we can hear you.

Do you have an estimate as to the length in footage that we're talking about when you connect up three average-sized trailers? Are we talking about something close to half the size of a football field—half the length?

Dr. LAW. I don't have specific numbers at my disposal, but, speaking personally, I would estimate—

Mr. VALENTINE. And isn't the—in addition to all other problems that might exist with this type of contraption, isn't the passing one of those things—I'm not talking about the tractor with three trailers passing other vehicles, but I'm talking about the passenger car trying to get around that thing and the length of time that you are exposed and when you're out there a blow-out could propel you up under those wheels. That, in itself, if there was nothing else involved — problems with uncoupling, problems with destruction of the highways—isn't just the danger in an ordinary passenger vehicle getting around one of those cotton-picking things enough of a problem to cause us to have serious concern?

Dr. LAW. I can't speak for ASME on the subject, but, speaking from personal experience, whenever you have a large discrepancy in the size of the vehicles that have to be on the same highway you are going to have those kinds of problems. And, of course, those problems are aggravated by the increasing size discrepancies.

Mr. VALENTINE. The trucking industry in North Carolina, they love me.

Mr. Roemer, the senior gentleman from Indiana.

Mr. ROEMER. Thank you, Mr. Chairman.

I'd just like to come back to this magnetic levitation idea and, Mr. Haack, you were talking about buzz words here. We have talked on this committee—and I'm sorry Mr. Thornton had to leave—about a Marshall plan that would reinvest not in the Middle East, not in Europe, but in this country; that reinvestment in education, investment in our financial sectors and industry to create these kind of products and services, investment in better roads and bridges, that's what is going to keep our jobs here and not have these jobs go offshore, as a couple of you mentioned in your testimony.

As you also mentioned, one of the travesties is that magnetic levitation—this whole idea was developed in our national laborato-

ries at Brookhaven in your sector, Mr. Haack, not far from where you work. We have to get that competition back here.

I also like the way you said in your testimony that maybe it is galvanizing the will rather than overcoming the institutional barriers here. It is not a question so much of cost; it is whether or not we are going to decide that this is a priority to keep jobs in this country and to compete.

I'd like you to specifically address how we galvanize the American industry and the financial sector to make these systems needed to operate the magnetic levitation train. Do we do it through the national labs? Give me some specific ideas as to ways by which we can work together in these different sectors to compete with the Japanese and the Germans, but more so galvanize the will internally in this country to keep our jobs here, which I am losing left and right in the midwest in manufacturing base where we pay people a decent wage.

Mr. HAACK. I think I go back again—as we talk about maglev, I want to include the high-speed rail and the comment my colleague made about the rail industry completely leaving our shores.

The locomotive that pulled my metroliner this morning wasn't built in the United States, and we were the greatest country in the world for building that type of device a number of years ago.

I think we have to get over this problem of the public seeing mass transit—rail, maglev—as something for the other person to use. It is fine with them as long as it is there, just don't make me use it. I really think that is important to the general public.

I'm not sure how you get the groundswell to keep those jobs here and to create the systems if we have a public that's not out there saying this is really good for us to have mass transit systems in place and willing to use those systems.

Mr. ROEMER. Well, even a step back from the public groundswell, where do we begin to bolster our development? As I said in my opening statement, we are very strong on the research end on developing the VCR or the magnetic levitation train, and then not so good in the development end in terms of commercially applying these things.

How do we specifically begin to get our private and academic sectors together? Is it through the national laboratories to develop this? My second part of the question is: where do we come up with the—how do we get the Federal dollar involved in this, too? I think Doctor Shladover also in his testimony referred a little bit to that. But I would like you to specifically address this cooperative effort that we need in terms of keeping our jobs in this country and getting our sectors to work together.

Mr. HAACK. I think it goes beyond those national laboratories. I think it has to come out in the demonstration projects where maglev systems are built and are functioning and can actually carry people. I think what we saw happen in Europe and what we have seen in Japan is just that. It started off with short systems that were put in place and were operating, and then it developed into systems.

I sort of would liken it to what was done—if my memory serves me correctly—in the early 1970s when a people-mover system was put in in West Virginia, if I recall correctly. Those early develop-

ments in people-mover systems came into— brought the systems that Westinghouse are now supplying for airports. We are all used to the—Tampa, Orlando, many airports are using those type of systems. It started out as a laboratory effort with horizontal elevators—that is effectively what a people-mover is—but it went out into the real world and there was a demonstration project and people in industry said, "Gee, that's not just some scientist's view in Brookhaven Laboratories. They have a product that will do something and that we can market here." I think that's what you have to do is bring it out.

How do you fund that? I think the demonstration projects have to be funded by the Federal Government.

Mr. ROEMER. And what are we talking about here? Doctor Shladover, if you could jump in, too?

Dr. SHLADOVER. On maglev specifically I would—

Mr. ROEMER. Or on high-speed rail.

Mr. SHLADOVER. I would tend to think—I use the analogy to IVHS, which I know we have talked about in other contexts, of getting government—both Federal and State government—and the industry people together in a combined organization, as has happened in IVHS, because it is difficult for the private sector to commit significant resources in one of these newer, more speculative areas if they don't feel a high level of confidence that the public sector is going to be in there for the long haul. These are significant systems. They are major changes from the way the systems operate today, and people who invest in those are taking a significant risk unless they feel that the Federal Government is going to be there with them for the long haul. And we know it is difficult to get multiple-year commitments of funding; nevertheless, these people feel they were left very vulnerable if the Federal priorities were to change suddenly a year or two downstream.

Mr. ROEMER. Mr. Haack, could you—in your testimony you talk a little bit about some of the technological challenges. Could you comment a little bit more on some of these challenges—the propulsion system, security problems, a couple of the potential health hazards? Would you go into some detail on three or four of those?

Mr. HAACK. Yes, sort of randomly. The security question—talking maglev now—the right-of-ways of our interstate highway system offer an opportunity for an elevated guideway system. With maglev that's very significant, where a rubber tire thrown onto the tracks of standard rail won't really make very much difference, but it sure will halt a maglev vehicle. The levitated space is very critical as those vehicles operate. So I'm suggesting that the elevated guideway, which has a great economy of right-of-way, provides a level of security to protect that guideway from debris being thrown on or people entering upon it. I think that is the security issue.

Mr. ROEMER. Which also increases the cost if you are elevating it by 15 or 20 feet, as they have in Germany. Is that true?

Mr. HAACK. I think there's a real offset in the space you are using because you are using very little space below when you elevate, so I think there is a real offset there. The pylons and the structure that you elevate to are not the most expensive in the world, and they're not heavy like standard what we call heavy rail.

The health question, which I think is being dealt with, is the magnetic field. There were a lot of concerns about the magnetic field in and around these devices a number of years ago. I think they are coming to deal with those issues now. I would certainly say it is a question that would have to be resolved clearly before a magnetic levitated system could be put into public operation.

Your other area that you wanted me to comment on?

Mr. ROEMER. Propulsion system.

Mr. HAACK. Propulsion systems. Back to—well, in the maglev there are two systems, one the Japanese system where the gap is about eight inches, and one the European system where the gap is about a half inch. They are both very different. The Japanese system depends on superconductors and the eight-inch gap is a lot easier to deal with. The half- inch gap becomes very critical in operation and it could be subject to ice and snow concerns. Probably even more important, when you look at those European type of maglev systems, the construction tolerances might drive the costs so high they would become impractical. You can't have any heave in the concrete if you are looking at a half-inch gap. So my comments in that area would lean towards the Japanese type of technology, which is more forgiving in the construction.

On the high-speed rail the question on propulsion becomes — it is obviously an electrically-driven system, and the propulsion concerns deal at real high speeds with the ability to pick up the overhead power lines and to continue to have power. Also—and I think this is important for our own rail systems in this country—there is a whole random mix of electrical voltages and DC and AC. I think standardization in that is very important as we go forward in the high-speed rail area.

I think also in the question of research there seems to be a magic number of somewhere about 300 miles an hour that the—whether it be high-speed rail or maglev. The TGV has operated at a speed of just about 300 miles an hour—not with people on board. If it went around the turn at that speed they'd be plastered on the side of the vehicle. But the TGV has operated at those speeds. Above that speed there are aerodynamic influences. There may be a practical limit at how high high-speed is. I have a feeling from what I have read on that subject that that number is somewhere in the range of 300 miles an hour.

I think, again, when we talk about speeds, it is important to keep in mind that the TGV is operating now at 180 miles an hour and it took a long number of years for the French to allow that speed to increase to that number.

Mr. ROEMER. One last question, Mr. Chairman.

As Mr. Lewis said, he estimated—or you estimated, actually—that the Germans have spent about $1 billion so far, the Japanese about $3 billion. Do you have any idea as to what we have invested in this? Lastly, I think Doctor Shladover commented on this, as well, too, or you did, talking about buzz words, is that some people said we were way behind on the high-definition television and through technological innovation and creativity I think we've caught up with a couple of breakthroughs lately. If you could comment both on what we have invested and give a quick assessment

as to us not being too far behind, hopefully, to make this technology work both here and to do something about our balance of trade.

Mr. HAACK. I can't respond to how much we have invested. I don't know that number.

Mr. ROEMER. Could you get that for the committee for the record, or could we get that, Mr. Chairman?

Mr. VALENTINE. Absolutely. Could you get that for us, Mr. Haack, and send it?

Mr. HAACK. I will do my best to try and get that.

Mr. VALENTINE. Thank you.

[The information to be supplied follows:]

ASCE AIR TRANSPORT DIVISION

Address reply to:

The Port Authority of NY & NJ
Aviation Planning Division
One World Trade Center - 65E
New York, NY 10048

May 7, 1991

Hon. Tim Valentine, Chairman
Subcommittee on Technology
and Competitiveness
U.S. House of Representatives
Committee on Science, Space and
Technology
Suite 2320 Rayburn House Office Building
Washington, DC 20515

Dear Congressman Valentine:

Following the hearing before your Subcommittee on April 16, 1991, I attempted to gather information on cumulative investment in research and development of Maglev and High Speed Rail in response to the request of the Subcommittee.

Unfortunately, I have not been able to find any single source that has accumulated cost data for R&D on these subjects. Due to the diversity in the subject I doubt seriously that a single, accurate, source of this information exists.

I am very sorry I am not able to respond to the request for this information.

Once again, allow me to thank you for the opportunity to appear before your Committee.

Sincerely,

Allan H. Haack

Allan H. Haack, Chairman
Transportation Policy Committee

AMERICAN SOCIETY OF CIVIL ENGINEERS
345 East 47th Street
New York, New York 10017-2398 (212) 705-7496

Mr. HAACK. Your other question: I can't come before the committee with a smile on my face and say we are in the same position that we would like to be in. I don't think we are. I don't think there is very much going on right now. I think people are sitting back and looking at what is done overseas. That's a crude assessment, but that's where I think we are. I don't think there's a lot going on. I think there is a lot of talk about it.

Dr. SHLADOVER. I think we may have to go back to Thomas Edison who I believe used the formula of 99 percent perspiration and 1 percent inspiration in terms of how inventions come about. I would not want to be so optimistic as to assume that there is going to be a silver bullet out there that somebody is going to find that will provide the basis for a leapfrog over these investments of either $1 billion or $3 billion. We could hope for that, but I'm not sure we should rely on that as a basis for making judgments about investing in the technology.

Mr. ROEMER. Thank you.

I just hope, Mr. Chairman, that our committee, under your leadership, can continue to make this an issue and that we don't, as we see ourselves now importing the metroliner that Mr. Haack came down here on, that we don't find ourselves in the next 20 years importing our fast metroliner silver bullet trains, or whatever we are going to call them. I hope that we provide some leadership here as you are doing, Mr. Chairman.

Thank you.

Mr. VALENTINE. Thank you.

The Chair recognizes the gentleman from California, Mr. Rohrabacher.

Mr. ROHRABACHER. Thank you, Mr. Chairman.

Just to offer another point of view, I don't really see that it is all that much of a terrible catastrophe to actually perhaps license technology that is developed overseas and use it here. Is there some reason why we have to be the leading power in maglev technology, why we can't just license it from the Germans and manufacture it here from the Japanese? Is this some catastrophe for the United States? I mean, other countries license our technology and use it when we do a better job. With all courtesy and due respect to my colleague, cost these days when we have a $350 billion deficit is a very important factor and actually is more important than willpower sometimes. It is financial power to actually pay for some of these things, and if our foreign friends are developing the technology and it is cheaper to license the technology and use it here, doesn't that make sense? Rather than channeling our money in there, channel our money in other areas where we can actually do a better job than our foreign competitors. Am I making any sense there? Would you like to comment on that?

Mr. HAACK. I'll just offer a comment on that.

I think when we spoke earlier about the rail industry and cars not generally being built in this country, in the New York metropolitan area a few years ago we put out a contract that—I believe it was the Japanese got it for cars—but we said they had to be built in the New York metropolitan region, and they formed an alliance with a New York company, built a factory, and constructed the cars there with Japanese technology. It was jobs for people in

our region, and it was very important to the region, so I think that sort of ties in to what you are saying.

Mr. ROHRABACHER. Well, I'm sure the Japanese license much of our technology, as do the Germans.

In my own area of Southern California where rapid transit and car transportation or transportation is a major issue, we are considering a maglev project that would be financed totally by private money that is based on the German technology. If we can save money by doing that rather than using the taxpayers' dollars in that we can use those tax dollars on other projects.

Mr. Haack, could you—we were talking about the life cycle of our road system—of course this, again, is another important issue in California—and the materials. We're finding materials is really perhaps the next major area of technological development in many things—engines, etc. Could you just give me a very brief summary of what development of new materials could do? I mean, how much money could that save us and what would it do for roads? You mentioned every seven years we have to repave the road.

Mr. HAACK. That's if we use asphalt, which is fairly typical in repairing. We are very good at building concrete roads because we are building them in a greenfield, but then when those roads go into service and we have to rebuild them we usually use asphalt because you can drive on it virtually the same day.

The newer materials that are being developed and are in fairly common use that will give a longer life cycle to paving are reinforcing bars that are coated with a non-corrosive material so that the reinforcing bar stays integral with the paving material. The use of very fine, almost hair-like, stainless steel wire that is put into a concrete mix that holds the concrete together and keeps it from cracking, that's starting to be done.

Mr. ROHRABACHER. Is there a great deal of research going on now in the materials for life cycle research for these type of building materials?

Mr. HAACK. I think in the organizations that—the professional organizations that are involved in paving— Portland Cement Association—does a good bit of research. There is always research going on within the Asphalt Institute to say asphalt is the better material. That's the type of research that is being done.

Also what is being done—and I think it is interesting — is, particularly in the asphalt area, is the use of the recycled automobile tires going into production of asphalt. Also, glass—recycled glass—going into paving material is an interesting thing that has come out of research. It is very good for our environment, it offers a less expensive aggregate material.

Mr. ROHRABACHER. Now I'm going to ask you a very pointed question. Do you own an automobile?

Mr. HAACK. Yes, I do.

Mr. ROHRABACHER. You made some very negative comments about people who own automobiles, and now you own an automobile.

Mr. HAACK. I'm also a mass transit user and a real believer in mass transit.

Mr. ROHRABACHER. All right.

Let me ask a question of Mr. French.

Mr. French, when you're talking about intelligent highways, is it going to be possible in the future for us basically to have toll roads that would then pay for themselves, new roads that would then pay for themselves and be able to be self-administrative almost with computers, etc.?

Mr. FRENCH. Certainly these are new types of administrative, institutional arrangements that would be enabled—greatly facilitated—by IVHS technologies—AVI, automatic vehicle identification; smart cars; toll debiting; road pricing, if you are going to be so bold as use that word, as well. But certainly the IVHS technologies will totally enable that sort of thing, but it will take other measures, of course, to bring about then—

Mr. ROHRABACHER. I—the people in California love their automobile. I love my car, and I bet you love your car, too. And there are some societal problems that stem from car ownership, but that doesn't necessarily mean that technology can't make a deal with those problems and that our freedom that is associated with being able to go where we want to go and when we want to go has to be something of the past.

Just one thought, Mr. Chairman, and I will give up this microphone, and that is: in Southern California we are now experimenting with toll roads, and there are ways to build roads not necessarily wider, but perhaps another lane or, excuse me, another layer that could pay for itself without any taxpayers' dollars. And at a time when we are struggling, we are really struggling to come up with the money for the health care of our citizens—I mean, we have an aging population. Social Security is going to be in trouble in 10 or 15 years. Medicare looks like it is already in trouble and we are going to be having—some of our emergency rooms are closing in California. Perhaps technology will permit us to build another layer on our freeway and then perhaps have it pay for itself and self-administer itself and perhaps the new layer might even last a lot longer and be a lot more cost effective than the level that it is supplementing. And that's just a thought.

Thank you very much for your testimony. I have learned a lot and I gained a great deal from your testimony today. Thank you very much.

Mr. VALENTINE. Thank you, sir.

Let me just ask one or two other questions, and then we'll be finished with this distinguished panel.

As I understand it, the practical application of maglev technology, there are only exhibits of that in two countries, Japan and Germany. And in Germany there is actually in operation a demonstration project, a vehicle that operates on the principal of magnetic levitation. That's correct?

Mr. HAACK. That's right.

Mr. VALENTINE. And we don't spend a lot of money on R&D in this area compared to what is spent on other projects in other areas, but we do spend several millions of dollars and it is true, I take it—and if this is not a true statement, I would ask any of you to indicate that—that what results, knowledge that comes, the practical application that comes from research and development in maglev is in the public domain. It is published in scientific publications, isn't it? I mean, that's the reason for it. You know we made

progress because scientists share with each other. And when it is published, it is available to everybody, including the Germans and Japanese. So we don't have any practical application of maglev in this country anywhere, do we? So when we spend taxpayers' money for research and development in this particular area, don't we really benefit the Japanese and Germans more than we do ourselves, because they have at least attempted a practical application of this? Don't we?

Mr. HAACK. I would comment that you are 100 percent correct, and that's why, in addressing Mr. Roemer before, I talked about a demonstration project where something was built and operated, taking it from the lab to an actual operation.

Mr. VALENTINE. I mean, it is a grand idea. There is no question about it. I can see—as a layman I can see certain real problems. I can't get it straight in my mind how the thing—it looks to me like it would be, to a large extent, an accident waiting to happen. How do you protect it against sabotage and even the forces of nature? Which leads me to ask you: is there a device in operation which you can put in that engine or the front car on a maglev train that can give a warning of a problem—a tire on the track a while down the road? Because at these speeds you need to know a heck of a long time before you get there, don't you?

Dr. SHLADOVER. You may need to know quite a few miles down the road at those speeds. We're not aware of the technology that could detect such obstacles at those distances.

Mr. VALENTINE. Do you know of any realistic or practical plan to build a maglev installation, a railroad, even a demonstration project anywhere in the United States?

Dr. SHLADOVER. There have certainly been discussions about building them in several inter-city corridors, corridors like Los Angeles-Las Vegas and Florida and Texas corridors.

Mr. VALENTINE. The train that operates in Japan is how long? And is it in practical, every-day service?

Mr. HAACK. The bullet train?

Mr. VALENTINE. Maglev.

Mr. HAACK. That's purely a test track.

Mr. VALENTINE. Well, I thank you very much. I don't think we need to pursue this. Thank you all very much for sharing this information and expertise with the committee.

Our next panel consists of three people, one of whom has a little different presentation. We'll call him next. We'll call the second panel. I suppose he will be seated with the other gentlemen for questions, but we'll hear at this time from Doctor Antoine Hobieka, who is director of Virginia Polytechnical Institute who has a slide show.

STATEMENT OF DR. ANTOINE HOBIEKA, DIRECTOR, VIRGINIA POLYTECHNICAL INSTITUTE

Dr. HOBIEKA. Mr. Chairman and Members of the Congress, thank you very much for inviting me to speak on the very important subject of intelligent vehicle highway system.

My name is Antoine Hobieka. I am the director of the University Center for Transportation Research at Virginia Polytechnical Insti-

tute and State University. I have submitted a written statement, but I am also using a different tract here in providing a slide presentation as part of my oral presentation, if you permit me.

I would like to stand up and maybe--

[Slide presentation.]

Dr. HOBIEKA. The problem of congestion is not new, Mr. Chairman and Members of Congress. It has been with us for a long time. If you look back in history, this is New York in the late 1800s where there was big congestion downtown in Broadway. It definitely has its own environmental problems.

But today, if you look, we have a different type of congestion. This is up in California where you have approximately ten lanes of parking plaza to deal with.

What we are trying to do about it, we're really trying to look at different advanced technologies to deal with the problem. You already heard several of these things this morning. One of them is alternative fuel, electric solar power, high-speed trains, maglev, tilt-rotor airplanes, and intelligent vehicle highway system.

Intelligent vehicle highway system is only one of these issues, and that's what will be the topic of my talk.

One of the goals of intelligent vehicle highway system is to address some of these problems—primarily congestion and safety and environmental quality. How we are doing it, we are doing it with interaction, looking at the road, the vehicle, and the driver together.

Previously we built the road, other people built the car, and we have a driver using it. Now we want to look at it as a system with cooperation between the car builders, the highway builders, and the drivers to really achieve an efficiency in our system.

What is the IVHS? As my colleague, Robert French, said this morning, it is a society that gets together. One of them is called Mobility 2000, came out with the acronym of IVHS. At the same time, came up with what are these issues that we are talking about, divided them into four factors—advanced traffic management systems, advanced driver information system, heavy vehicle and commercial operation, and automated highway vehicle control. I'll be talking about each one very quickly.

The elements of advanced traffic management system, we have a center which is down here, traffic control center that collects information from sensors in the car from TV stations and on the freeway, brings them down to this control center, and that control center controls the ramps down here. It also gives a very good message sign to the driver. Also gives information—what is the best way to go—and also gives information to the police and to rescue.

You see that this traffic control center, we have at least 15 of them in the United States right now; however, they control only a certain part of the freeway. We want to extend their function to a network in an urban area in order to really maximize the use of the capacity of the highway network involved and, at the same time, expand its relationship not only to get information to the driver on the road, but also to give information to the people at home and at the work place.

Part of this is to do it through navigation systems. In the car we have—this is on the dashboard of the car—that can tell you what

is the location of the vehicle on the highway network and, at the same time, the traffic control center can advise this driver through the screen what is the best way to go to get to the destination.

This is also, from the safety point of view—we have mechanisms nowadays to be put on the car in order to see in the blind spot whether a car is really behind you, and if this car wants to get into the left lane an audio or a visual warning system would come to the driver and tell him that there is a car in the blind spot and he cannot make the left turn.

On the heavy vehicle and commercial navigation, heavy vehicle and commercial operations, we have a satellite system that gets information from the truck and transmits it to a control center. The control center then advises the truck what is the best way to go, what is the next best pick up in order to enhance the efficiency of the operations of trucks and also be able to track certain hazardous materials on the roads.

In terms of automated highway vehicle control system, this is an envisioned solution in order to improve the capacity of the highway and the safety of it is to provide forward guidance and to keep headways between cars at a minimum by using radar braking and also, later on in this process, to be able to have skidding control by using certain sensors in the road that keeps this vehicle in its lane which is called lateral control. When you achieve these forward and lateral control and collision avoidance, you'll be able to achieve what we call automated highway vehicle control system.

What is the timetable for these issues? We already, as my colleague said before, we have a Pathfinder project in Los Angeles and TravTek in Florida. We have these issues, progressed by time, from display to obstacle detection, vision enhancement and detection, and to automated highway in the year 2020.

This board on the right here is an illustration of what the future car would be in terms of these systems. This has a telephone and FAX machine, and this is also your computer display up here, and this is the headlight display in front of the driver, and this is the eye that can tell you there is obstacles or warnings about the sides of the car. There is no more steering in here—push buttons and all that.

What we are trying to do, to go back to the horse scenario, is the fact we want to make the future car more or less like the advanced horse where it can go at high speed closer together and be able to send it back home again.

Thank you.

[The prepared statement of Dr. Hobieka follows:]

WRITTEN STATEMENT ON
INTELLIGENT VEHICLE/HIGHWAY SYSTEMS

BY

DR. ANTOINE G. HOBEIKA, DIRECTOR
CENTER FOR TRANSPORTATION RESEARCH
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

PREPARED FOR
THE HEARINGS ON
SURFACE TRANSPORTATION RESEARCH AND DEVELOPMENT
SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
APRIL 16, 1991

Automobile transportation in the United States provides a high level of mobility but poses several operational problems--problems that can be mitigated with appropriate technology. Each year, almost 46,000 people die and 2 million people are injured as a result of automobile accidents. Direct costs incurred as a result of these accidents exceed $10 billion. Delays caused by congestion cost the nation even more: $100 billion per year. Moreover, these statistics will rise dramatically. Federal and state officials are concerned about the increase in these costs as the number of vehicle miles traveled will increase from 1.9 trillion miles per year to 3.8 trillion by the year 2020.

Through applications of technology, driver and passenger safety can be enhanced; energy efficiency can be improved; and the environmental and economic impacts that are currently experienced through commercial vehicle and automobile transportation can be reduced.

Plans are underway to address these problems with systems that employ a combination of "smart" cars and "smart" highways, often referred to as the Intelligent Vehicle/Highway System (IVHS).

Like other major technological challenges confronting the U.S. today, **IVHS requires cooperation between government agencies, research institutions, and private industry** in order to effect change. Indeed, the U.S. is already lagging behind Japan and several European countries in the pursuit to implement IVHS. They have already dedicated $2 billion to researching and developing IVHS technology.

Efforts within the United States, by comparison, are modest. In California, Florida, New York, and Minnesota, for example, plans

have been developed to adapt portions of existing highways into smart corridors. Changeable message signs, regulation of traffic entering the corridor, and information about alternate routes for motorists will be provided. General Motors is participating in the California and Florida projects by dedicating several cars with built-in navigation systems.

Most IVHS projects are primarily focused on alleviating congestion in urban areas. The problems of inter-city and rural transportation are also important and inter-city IVHS need to be developed, particularly if these systems are to be deployed nationwide. Inter-city roads are the primary routes employed by truck traffic, and are the site of a disproportionate percentage of accidents: more than half of all fatal accidents occur in rural areas where collision speeds are likely to be high.

Intelligent Vehicle/Highway Systems are divided into four categories:

- Advanced Traffic Management Systems (ATMS)
- Advanced Traveler Information System (ATIS)
- Commercial Vehicle Operations (CVO)
- Automated Vehicle Control Systems (AVCS)

Advanced Traffic Management Systems employ surveillance equipments to detect traffic conditions in a metropolitan area and transmit the information to a traffic control center. The control center processes the information and combines it with information from other sources to:

- develop ramp metering rates and traffic signal timing to meet current and anticipated traffic conditions
- advise people about current and expected traffic conditions
- inform police and people of the location, severity and expected duration of incidents
- recommend the best routes for people to take to reach their destinations

Current traffic control centers provide most of this information. However, their coverage is limited to certain sections of urban freeways. The intent of ATMS is to broaden the surveillance coverage to the whole freeway and urban arterial system of an urban area in order to make use of total highway capacity and provide area-wide information to motorists.

ATMS will reduce congestion by improving traffic flow, and will reduce accidents and emissions. Early estimates indicate that these systems may reduce travel time by 15%, fuel consumption by 7% and emissions by 14%. The largest benefits may be reaped during incidents. Incidents contribute to more than half of the time-delays and waste in fuel consumption in urban areas.

Advanced Traveler Information Systems (ATIS) will provide information to drivers, transit users, and travelers at home and at work. They will provide drivers with information on congestion and alternate routes, navigation and location, and roadway conditions through audio and visual means in the vehicle. This information might include incident locations, location of fog or ice on the roadway, alternate routes, recommended speeds, and lane restrictions. ATIS will provide information that would assist in trip planning at home, at work, and by operators of vehicle fleets. Transit users will also receive information from ATIS about schedules, fares, and expected arrival and departure times of buses and trains at transit stations. ATIS will also provide information on motorist services, such as tourist attractions, hospitals, and the nearest service stations and truck and rest stops. ATIS could include on-board displays that replicate warning or navigational roadside signs when they may be obscured during inclement weather or when the message should be changed, as when speed limits should be lowered on approaches to freeway segments or fog areas. This information would particularly help truck drivers in negotiating steep slopes and sharp curves under inclement weather conditions to prevent truck accidents and truck tipping. Overturned trucks have blocked major highways for many hours, and are a major concern to highway users and operators. An automatic Mayday feature may also be incorporated, which would provide the capability to automatically summon emergency assistance and provide vehicle location.

Commercial vehicles are leading the way in the applications of IVHS technologies. Already they are using automatic vehicle location, tracking, and two way communications; routing algorithms for dispatch; and in-vehicle text and map displays.

IVHS technologies, such as weigh-in-motion sensors, automated vehicle identification transponders, and automated vehicle classification devices-some already deployed-will reduce the time spent in weigh stations, reduce labor costs to states, and minimize red tape for commercial operators.

IVHS technologies are emerging as the key tools that carriers need to reduce costs and improve productivity. These productivity improvements have a direct impact on the quality and competitiveness of U.S. businesses and industries at both the national and international levels.

Advanced Vehicle Control Systems enhance vehicle control by facilitating and augmenting driver performance. Ultimately, it is envisaged that they will relieve the driver of most driving tasks in high-demand traffic corridors, or on long-distance, high speed trips. Three levels of AVCS technology are anticipated and planned:

- Level I. Autonomous Driver - Vehicle Systems. Early AVCS

technologies include vehicle-based radar-type systems that detect the presence of obstacles or other vehicles providing the split second of warning that could prevent most rear-end collisions and intersection accidents.

- Level II. Cooperative Driver - Vehicle - Highway Systems. Intermediate AVCS technologies will initially implement lateral and longitudinal vehicle control functions in specific applications such as high occupancy vehicle (HOV) lanes. Vehicles would enter the lanes voluntarily under manual control, but once in the lane, would be under full or partial control, leading to the realization of higher speeds, increased throughput and reduced collisions.

- Level III. Automated Highway Systems. The long term, most comprehensive AVCS application would completely take over driving tasks on dedicated highways. These systems will be especially effective in "automatic chauffeuring" of vehicles from on-ramp arrival to off-ramp departure, increasing the throughput of traffic in both urban and intercity traffic corridors,and realizing a new level of safety and mobility through high-speed operation in interstate travel.

While certain elements of ATMS, ATIS, and CVO systems are now being deployed, each will benefit from additional research. AVCS will require substantial research before it can become operational.

Research on ATMS will include development of sensors, improved software for management of traffic signals, and development of expert systems to assist in incident management. Much study is necessary to determine the response of drivers to ATMS, and operator effectiveness in managing ATMS.

Research on ATIS will address improvement of vehicle navigation systems, and the development of communication systems to link vehicle navigation systems with traffic information provided by ATMS. Much needs to be learned about traveler response to ATIS from human factors research. The impacts of ATIS on travel patterns and use of mass transit need to be fully investigated. In addition, there are many issues of liability and standardization that must be resolved before ATIS can become fully operational.

Research on CVO will include transponder development to assure vehicle-to-roadside communication of essential information. Research on route guidance and communication technology will lead to improved systems. Human factors research to assure compatibility of the driver within these systems is essential. Research on vehicle dynamics and sensors will improve control and reduce accidents.

AVCS cannot be deployed without more research. Much more must be learned about the availability and reliability of devices that detect the spatial relationship of a vehicle to obstacles or other vehicles, and to use this information for automatic control. The automatic control system of the vehicle must change speed at a rate compatible with equipment and human limitations. Extensive full-scale testing facilities will ultimately be required in order to evaluate promising concepts. Introduction of these systems will require special traffic lanes for the AVCS-equipped vehicles. Automatic inspection procedures must be developed to check for functional AVCS before a vehicle enters the lane.

Field operational tests are essential to test IVHS technology performance and cost-effectiveness. They will also assess user acceptance and market penetration. Conducting these tests is important to show the public that the IVHS program works. However, these tests require a substantial commitment of resources. Government, industry, and university should cooperate in performing the field tests.

Mr. Alan Smith, Executive Vice-President of General Motors Corporation, recently said "I think we are at a point now where we are committed to development of Intelligent Vehicle/Highway Systems for this country. We think the time is right to move ahead now."

IVHS program will eventually benefit every driver in this country. It is also a program that advances U.S. technology and its international competitiveness.

Acknowledgements

Much of the material in this statement was derived from the Mobility 2000 working reports. The individuals that prepared these reports are too numerous to mention here, but their contributions deserve recognition.

ORAL PRESENTATION OF

DR. ANTOINE G. HOBEIKA, DIRECTOR

CENTER FOR TRANSPORTATION RESEARCH

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

ON

INTELLIGENT VEHICLE/HIGHWAY SYSTEMS

PREPARED FOR

THE HEARINGS ON

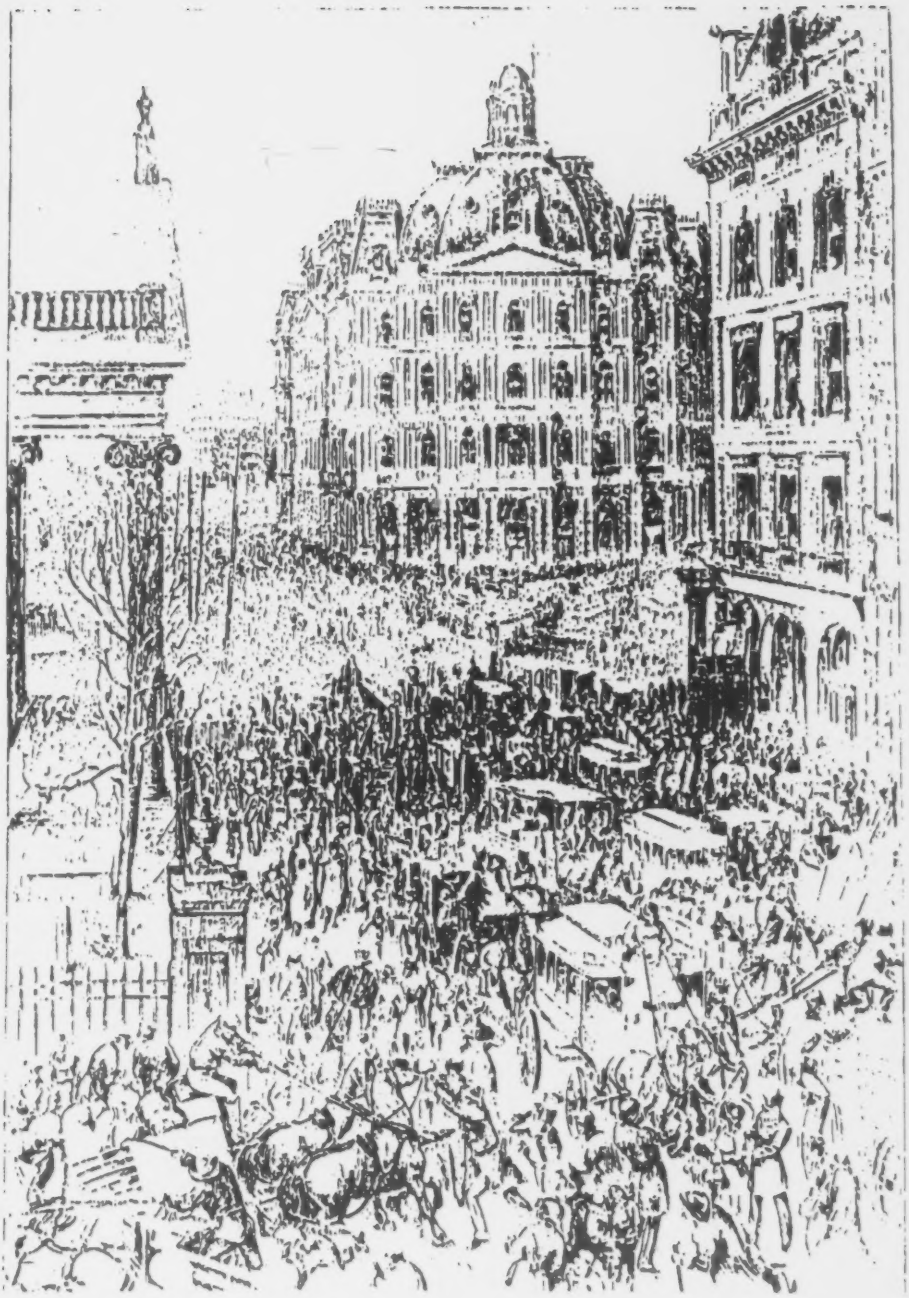
SURFACE TRANSPORTATION RESEARCH AND DEVELOPMENT

SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

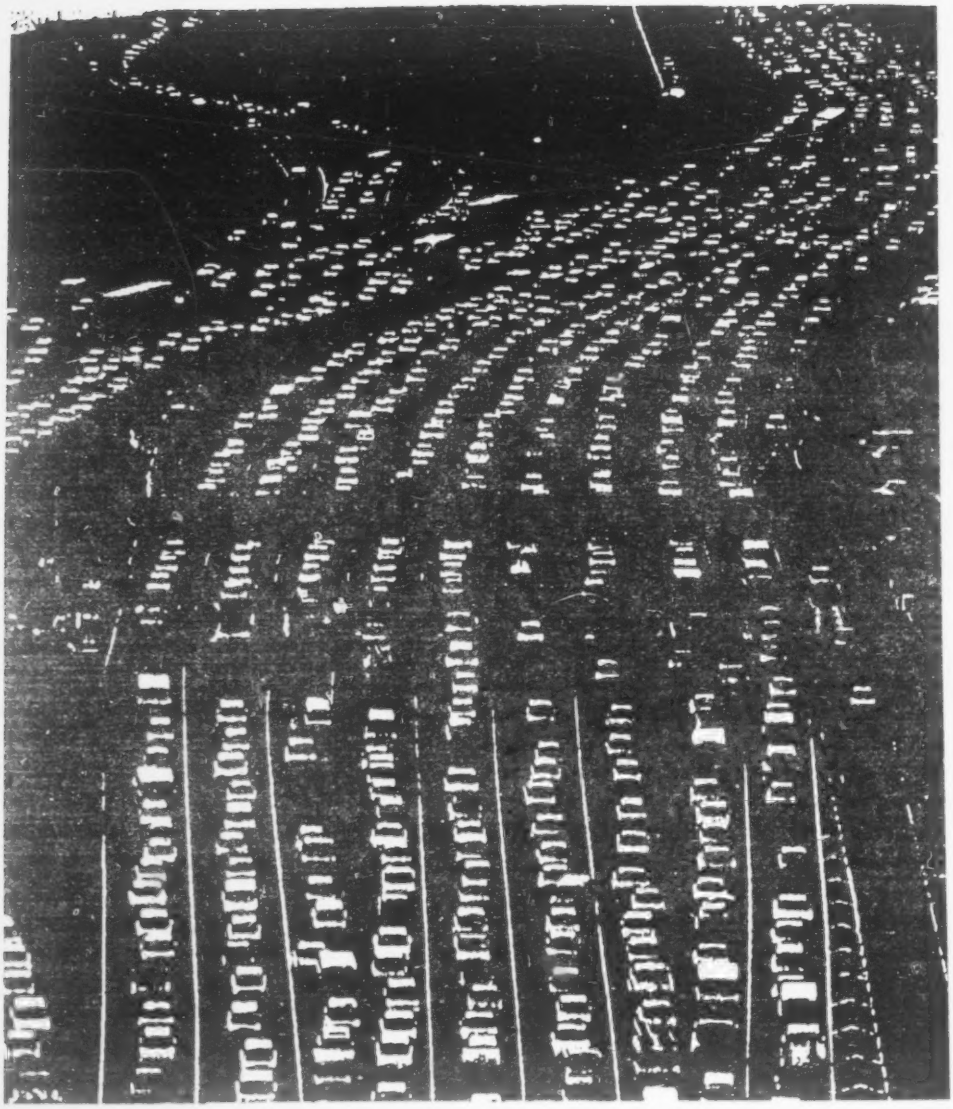
U.S. HOUSE OF REPRESENTATIVES

APRIL 16, 1991



Traffic Jams in the Age of the Horse

New York's Broadway



Rush Hour — Creeping to Work

Oakland, California

ADVANCED TECHNOLOGIES IN TRANSPORTATION

- Alternative Fuels
- Electric/Solar Cars
- High Speed Trains (MAGLEV)
- Tiltrotor Airplanes
- Intelligent Vehicle/Highway Systems

GOALS OF

INTELLIGENT VEHICLE/HIGHWAY SYSTEMS (IVHS)

Improve

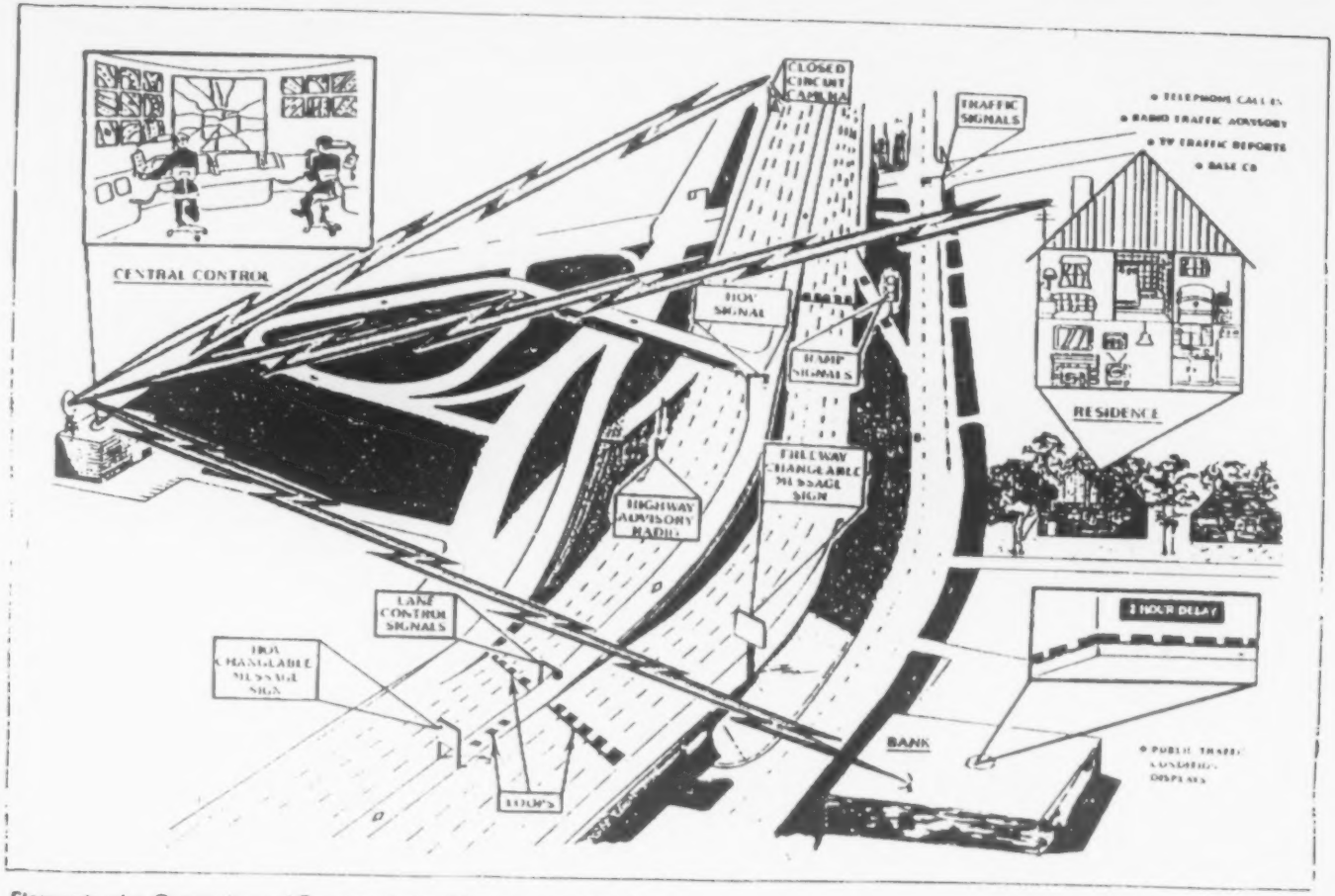
- Highway Safety
- Operating Efficiency
- Energy Utilization
- Environmental Quality

Achieved Through Improved Interaction Between

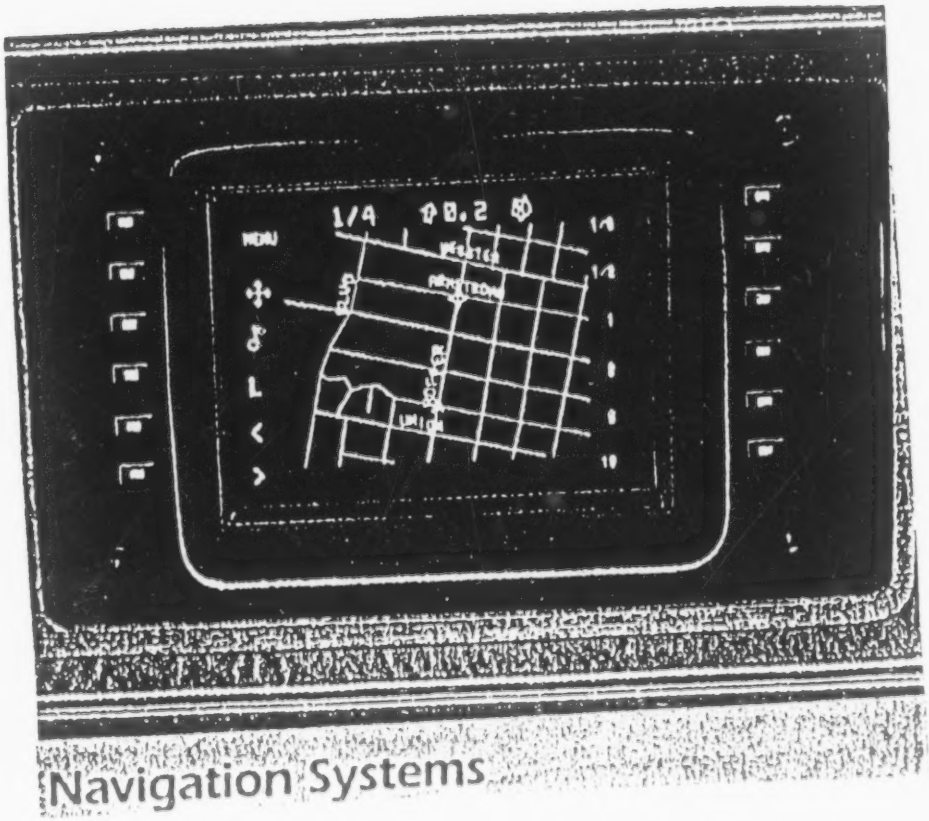
Roads, Vehicles, and Drivers

ELEMENTS

- Advanced Traffic Management Systems (ATMS)
- Advanced Driver Information Systems (ADIS)
- Heavy Vehicle and Commercial Operations (HVCO)
- Automated Highway/Vehicle Control Systems (AHVCS)

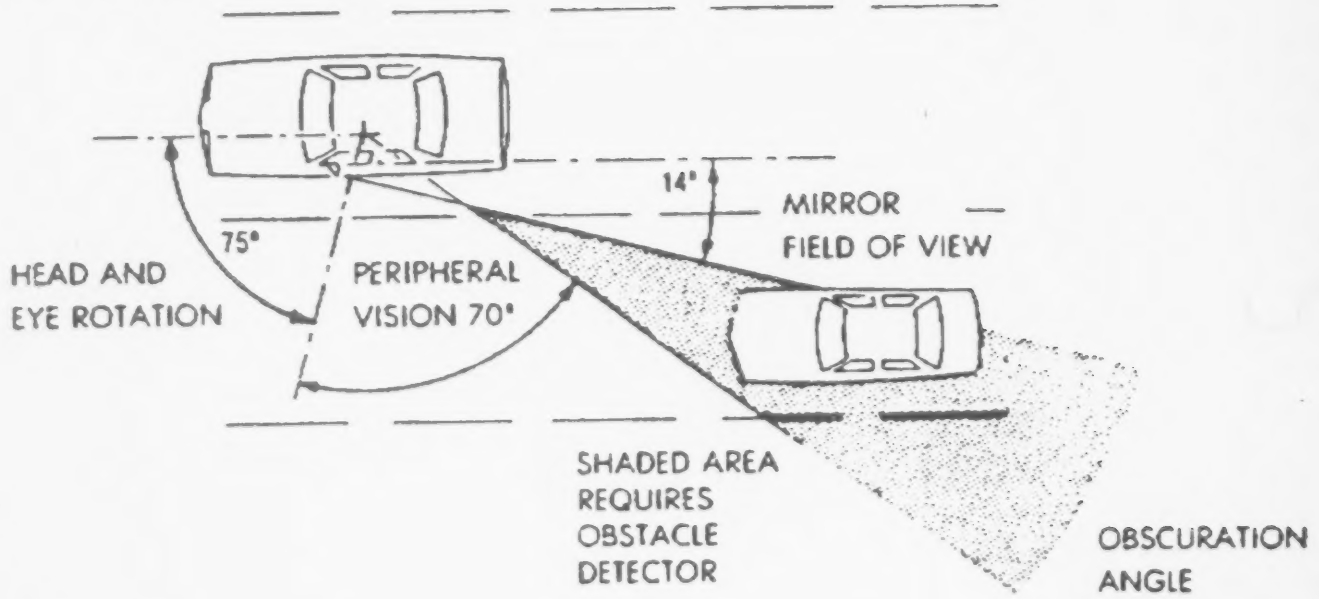


Elements of a Computerized Transportation Management System



Navigation Systems

BLIND SPOT DETECTION:



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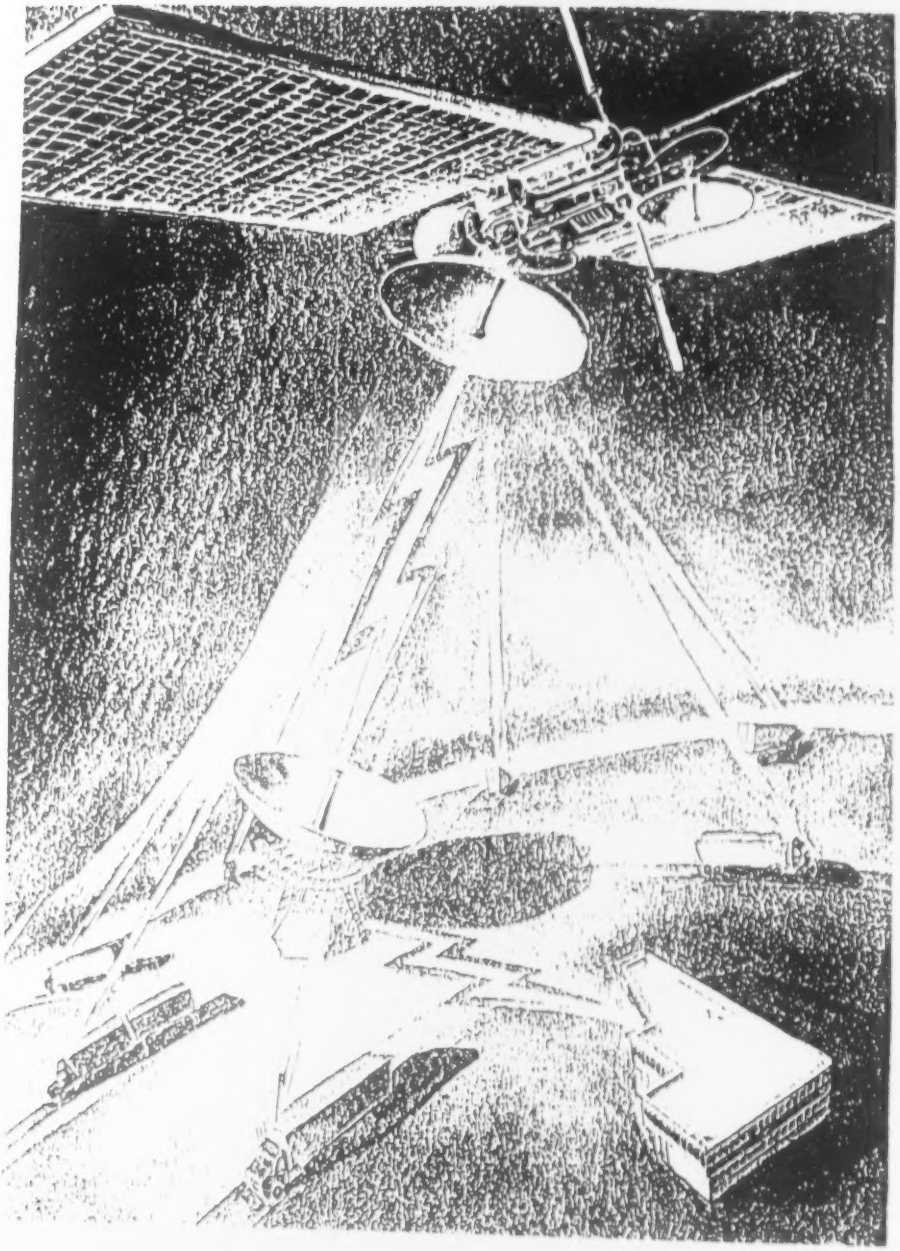
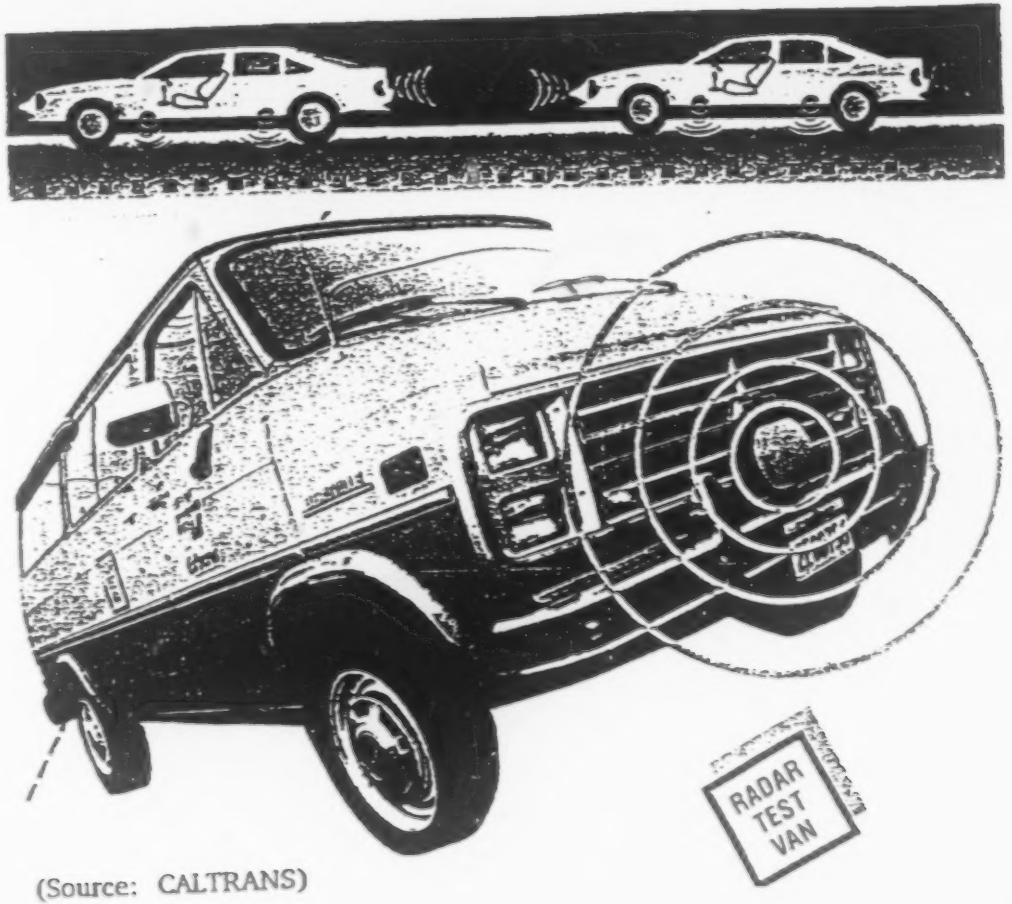
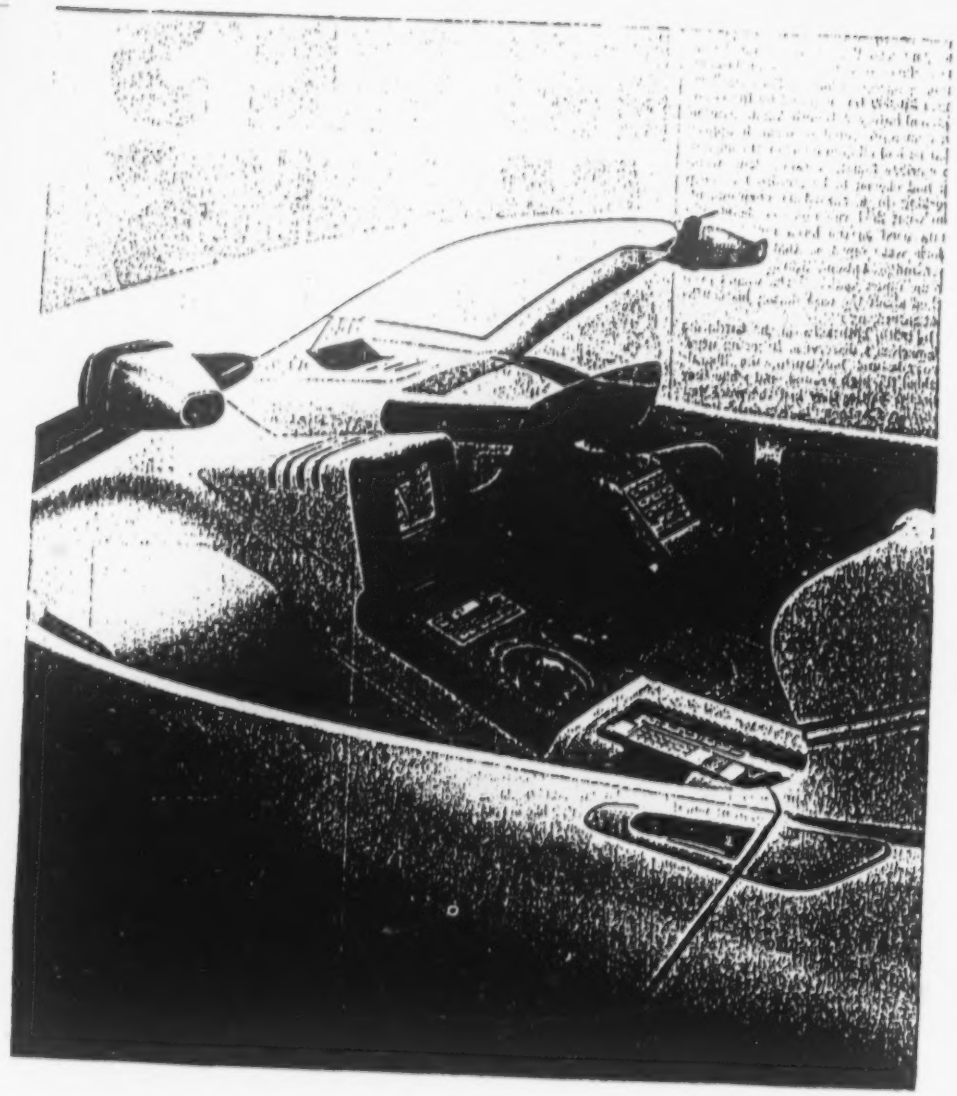
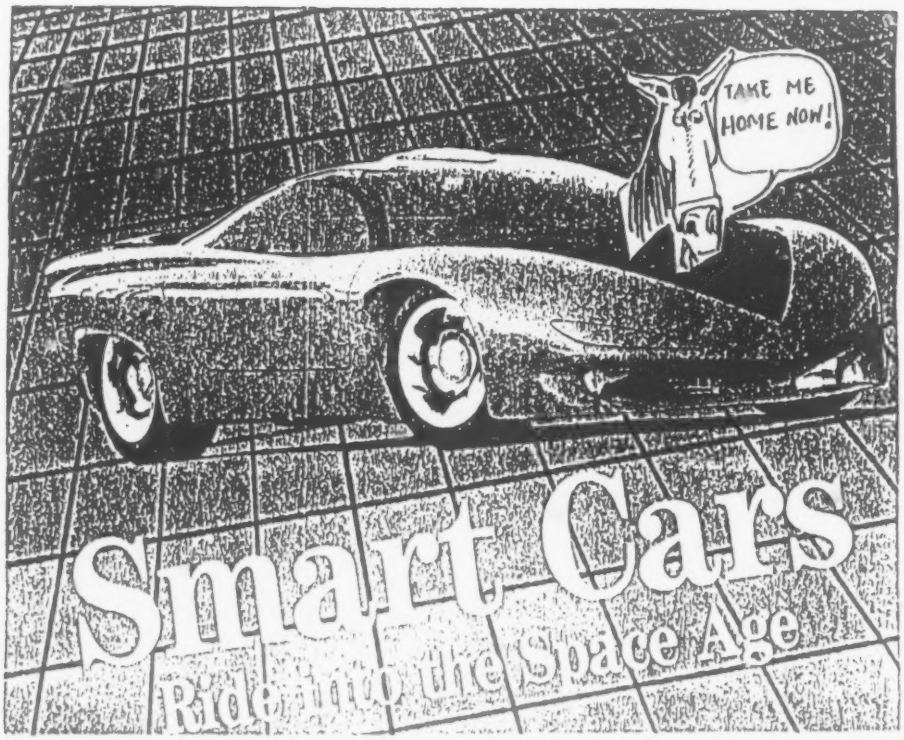




(Source: CALTRANS)

IVHS - TIMETABLE




TAKE ME HOME NOW!
Smart Cars
Ride into the Space Age

Mr. VALENTINE. Thank you, sir.

Dr., while you are dismantling your equipment, I would feel like asking you just a question or two before we get to call your colleagues down here for the last panel.

Is there—the other gentleman, Doctor Gary L. McAllister, who is Manager of Applied Physics and Civil Programs R&D of the Bechtel Group is on this panel, and Mr. Brian T. Barcelo, Director of Service Development and Marketing Research, AT&T Network Systems. I know this is your field, but do you have any feel for how this, a substantial expenditure, a real national effort in this area, would rank amongst our nation's national priorities? Isn't this really a goal of something that we might contemplate way off in the future? Or do you see it as an imminent possibility? And isn't it perhaps one of the most expensive initiatives that the mind of man could conjure up? It is a system whereby there is integration between or amongst those who build the highways and those who build the cars and we have automobiles that really you put them on a highway and they move about without a lot of interference from the driver. Isn't that where we are headed?

Dr. HOBIEKA. That's the future dream. There is different steps to get there, and I only stated some of them. I don't think that this is really a very expensive venture from infrastructure point of view. There is a lot of it to be developed in the vehicle itself and by vehicle manufacturers. But on the highway side—and I think the investment is modest. I want to say that—there isn't really much to be, except for communication and ability to tell the driver certain things.

Mr. VALENTINE. But if we are going to develop the system that will tell a driver of an automobile who lives out in McLean, Virginia, by some kind of schematic on his dashboard what's the best route for him to take to get to work, where the traffic jams are, isn't that something that really literally boggles the imagination insofar as expense is concerned?

Dr. HOBIEKA. I don't think so. For my modest opinion, I think it is not. We already have some of these already here. We do have a traffic control center here in Arlington, Virginia, that could be expanded to do this. Most of urban areas are already going to utilize these centers in order to control their traffic and call it freeway incident management, to control the incidents on freeway. They are trying to collect information from the freeway and from a different part of it in order to have better management of our freeway system.

As beside, the other advantage of it is that some of that information collection you can use it to enhance other functions is to be able to provide better information to the driver what is the best way to go around and to get around bottlenecks and incidents.

Mr. VALENTINE. Further being the devil's advocate, when you have first-class highways you have the best opportunities for human vision—forward, aft, laterally—and you have the best equipment surrounding the driver that can be created, and you have the best lighting that is available, and what is there that is better than the brain of that driver?

Dr. HOBIEKA. The future problem is we want to minimize the task of the driver, not to increase the task of it, and to make that a

way to achieve better efficiency. One of the problems is the fact now we keep a distance between two cars close to 20 feet at 50 miles an hour. If we have the opportunity to reduce that by half, we double the capacity of the system. The only way we can do it is to automate it, and if we can automate it we can take the human element out of the loop and to be able to create that, then we'd be able to increase that capacity.

This is a possibility—it is not a dream—if we can test it and develop the R&D for it and be able to achieve it in the distant future.

Mr. VALENTINE. And to do this, the reasons we would want to do it would be two-fold, wouldn't they? One would be safety, and one would be efficiency. Well, we're not concerned about safety in this country. If we were concerned about safety, we wouldn't have raised the speed limit. If we were concerned about safety we would have long ago required every automobile manufacturer to have the air bag. If we were really concerned about safety there would not even be any discussion about triple trailers, would there?

So are we really—we don't have to go all out to these sophisticated technologies of the future. Safety is right here. If we were really concerned about safety, we wouldn't make it so that it is legal for a person to buy a machine, the sole purpose of which is to find out where the cop is.

Never mind. You don't have to answer all that stuff. Just thinking aloud. I say again, being the devil's advocate, when I look at things that our nation needs—the eradication of illiteracy—I must say that some of these things that we are talking about here today seem to me to be way down on the list of what our country needs, it seems to me.

Dr. HOBIEKA. If you will permit me, sir, I—there is definitely a lot of competing issues, and they are all very worthy. But, as you know, transportation constitutes 20 percent of our GNP and it is a very important factor to our productivity and international competitiveness. Any advancements that can enhance our productivity in the transportation sector is felt throughout all our economy and it is an important issue that we should address so that—we don't want to wake up again and lose our highway advantage as we lost our rail advantage and other things.

We are in a very competitive mode, and it is a very important issue to our industry and our economy. A small sacrifice in R&D in that area I think it would go a long way to improve our productivity and international competitiveness.

Mr. VALENTINE. You are exactly right, and it is a small amount, isn't it?

Dr. HOBIEKA. I think so.

Mr. VALENTINE. Very small as far as you are concerned.

Do you have any questions?

Mr. LEWIS. I just wanted to know, Doctor, what do— following up on the chairman, what kind of research are we going to do to the illiterate driver? You do all of these other smart things for the vehicle, we've still got the human behind the wheel—amplified every day as you drive through Washington.

Dr. HOBIEKA. Maybe you should think—

Mr. LEWIS. Taxi drivers.

Dr. HOBIEKA. If they'd be able to drive the car, then we made them literate. It is a very important question. However, in the design of these systems we're making it to the average car. We are not going to take a high test in order to be able to drive these vehicles. Similarly, I don't think anybody really these days—any kid, whether he goes to school or not, he can play Nintendo very well.

Mr. LEWIS. I think you make an interesting point when you pointed out about stacking more vehicles on the highway. I don't think we even give too much consideration to a two- lane highway where we are passing each other at 55 miles an hour with maybe sometimes six inches between the cars of maybe two feet six inches, something like that. We do have to in some way come up with a smarter highway system to meet the transportation problem.

Dr. HOBIEKA. I totally agree with you, sir. Statistics say that 57 percent of the fatal accidents occur on straight stretches of road, and one of them is the two-way road. A small investment in making sure that the vehicle stays in its own lane, even make sure that when it crosses that lane a certain warning system comes to the driver in telling them you crossed it, either due to fatigue or due to other things, then that can really save a lot of lives and help the safety issue of our driving.

Mr. LEWIS. Thank you, Mr. Chairman.

Mr. VALENTINE. Thank you.

Dr. McAllister and Dr. Barcelo, welcome. We invite you to summarize, if you would. Your prepared statements will appear in the record as presented to us.

Dr. McAllister?

STATEMENT OF DR. GARY L. MCALLISTER, MANAGER, APPLIED PHYSICS AND CIVIL PROGRAMS R&D, BECHTEL GROUP, INC., WASHINGTON, D.C.

Dr. MCALLISTER. Thank you, Mr. Chairman and subcommittee members.

I am Gary McAllister, as you said. I am the manager of Applied Physics and Civil Programs for Bechtel Corporation's Research and Development Organization. I am pleased to have the opportunity to share my thoughts with you on the surface transportation, and I will address my remarks primarily towards maglev.

You have already had considerable discussion this morning on maglev, but let me just reiterate the key reasons for interest in maglev.

First of all, it does have the passenger carrying capability to make a significant change in the congestion for aircraft and for automobiles, so it can be important from that standpoint. Second, there was some discussion of safety, but maglev has the potential to eliminate the prospects for either head-on or rear-end collision, so it has, as I say, the potential to be extremely safe even at very high speeds.

It also has lower energy consumption than either short- haul aircraft or automobiles.

Finally, being an all-electric system, it has the prospects of using primarily non-petroleum fuel sources since less than 20 percent of our electric power is generated from using oil.

The status of maglev, technically it does work. There was considerable discussion earlier regarding the U.S. and foreign operations, but the U.S. did run several scale-sized models in the middle 1970s and, as was stated, both Germany and Japan are operating full-scale prototypes on test tracks of several miles.

The Federal Railroad Administration, the Corps of Engineers, and the Department of Energy are now sponsoring the national maglev initiative with the intention of assessing the viability of U.S. maglev, with the emphasis again on safety, reliability, environmental quality, and, in my own opinion above all, the costs—economics of the system.

Now moving to applied R&D and the implications for commercializing applied R&D, I'd like to contrast two sides of it. First of all, on the side of construction materials— for example, high-strength concrete or fiber reinforcement— this is typically an area that requires strenuous code acceptance and the systems that are built require durabilities in lifetimes of many decades. As a result, the process for putting it into commercial use is very lengthy. Secondly, construction companies are reluctant to use innovations until they are well demonstrated and well proven.

On the other hand, on the more optimistic side, we have been very active and have been very fast at implementing simulation, analysis capability, modeling capability. We are now at a point where we can routinely design in three dimensions. We can use those designs to automatically check for component interferences, which are used to take many lengthy processes. We are able to—with three-dimensional and/or video representation, we are able to preview entire operation procedures which, in many cases, can eliminate a small-scale model—well, several generations of small-scale models.

Just as an example, the subcommittee mentioned earlier the issue of magnetic fields. We now, over the last few years, have been able to do full three-dimensional modeling of magnetic field analysis which, as I said, can greatly reduce the length of time required to put something into practical application.

What I think is needed now is a convincingly stable government program to take us through the first steps and then into the subsequent steps. The government needs to act as the initiator—which they are already doing—the facilitator, and the developer for a U.S. maglev system. The FRA program is now in a system concept design study, as I said earlier, to assess the viability.

The Federal Government must take the lead in the areas of rights-of-way, in the areas of safety standards, and the area of general standards. And by that I mean, for example, the guideway construction which, as someone said earlier, is a major part of the construction cost. We would like to have a uniform guideway throughout the country rather than having this grow up with mix and match or mix and non-matching guideway systems.

The first step is underway, namely the system concept designs and the technology assessments. What we need to do is move forward assuming that we are going to get an encouraging result from

this, not break up the program only to restart it later, to move it smoothly into the next stage.

Thank you for letting me share my comments with you. I'd be happy to answer questions.

[The prepared statement of Dr. McAllister follows:]

Testimony of Gary L. McAllister

before the

SUBCOMMITTEE ON TECHNOLOGY & COMPETITIVENESS

of the

U.S. House of Representatives

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

April 16, 1991

INTRODUCTION

Mr. Chairman, I am Gary L. McAllister, and I am Manager of Applied Physics and Civil Programs in Research & Development of Bechtel Group, Inc. My company and I are pleased to have this opportunity to appear before this Subcommittee on the subject of applied research and development in the transportation industry, with specific application to magnetically levitated (maglev) systems.

Domestically, transportation is a major sector of the U.S. economy, accounting for approximately $800 billion annually. The average ground transportation speed has been decreasing and the average delay for an airline passenger has been increasing. Highway travel delays exceed two billion hours annually and 21 primary airports exceed 20,000 hours annual flight delays. These factors not only decrease the productivity for users but they also raise the absolute cost of transportation, increase the environmental pollution, and frustrate the systems users.

We are now at a point in this country where we have the opportunity, with magnetically levitated transportation, to build on research and development carried out during the last 25 years and to significantly improve the U.S. transportation system. The potential benefits are many: passenger safety, high average speed, low energy consumption, and environmental quality.

Work is already underway on major maglev transportation systems. Germany and Japan have each spent approximately more than $1 billion to develop and operate maglev vehicles on test tracks which are several miles long. Each of the two countries is in the process of implementing their maglev technology into commercial transportation systems. Bechtel is now teamed with Transrapid International to utilize their technology for a maglev system which would connect Anaheim, CA, and Las Vegas, NV.

One key to large scale application of maglev is to lower the life-cycle costs by reducing the capital cost for construction and/or operating costs. Applied research and development can have a major impact on these costs. This includes advances on the product side such as have occurred in high strength, low weight materials, superconducting magnets, and automation, and on the services technology side, which includes improved analysis capability, advanced modelling and simulation, and more powerful project control technologies.

The National Maglev Initiative, sponsored by the Federal Railroad Administration, the Army Corps of Engineers and the Department of Energy, is assessing the engineering, economic and environmental feasibility of maglev in the U.S. It is important that this assessment move vigorously forward if we wish to develop U.S. maglev rather than importing all future maglev into the U.S.

MAGLEV BACKGROUND

Intercity transportation times have increased for both aviation and automobile users. Aviation congestion, in 1986, contributed to passenger delays of more than three million hours each at eleven U.S. airports with a total delay of more than 60 million hours. Freeway congestion has reduced average speeds to a point where even intercity travel is slowed by intracity traffic density. During the peak morning and afternoon traffic the average freeway speed in Los Angeles is about 20 miles per hour. Maglev can help reduce both aircraft and auto congestion by replacing much of the short-haul aircraft traffic (600 miles or less) and a smaller fraction of the automobile traffic.

In addition to the potential ride performance and cost benefits, there are potential safety and environmental benefits with maglev. One motor vehicle traffic death occurs, on average, for each 60 million passenger miles. Although aviation travel is much safer, there is still, on average, one death per 600 million passenger miles. A properly designed maglev system should be capable of far superior safety performance. Separated guideways for oppositely directed traffic will prevent head-on collisions between vehicles. The electrically propelled maglev vehicles envisioned will receive their power from guideway segments where only one vehicle can be powered in a given segment, thus preventing rear-end collisions.

Maglev is envisioned to be an all-electric system with essentially no local pollution. Since less than twenty percent of our electrical power is fueled by petroleum, maglev can reduce petroleum consumption. Further, maglev is projected to be approximately two times more energy efficient than automobiles and four times more energy efficient than short-haul aircraft. Thus there can be a net saving of energy, reduced use of petroleum, and greater energy efficiency for aircraft and automobiles because of reduced congestion.

With the strong potential benefits exhibited by maglev, it is important to investigate systems applicable to the U.S. Much of the early research and many of the maglev inventions resulted from U.S. work in the late 1960's and the early 1970's. Most U.S. work terminated in 1975, but work has continued in Germany and Japan. The German system is generally accepted as being closer to commercial application with hundreds of hours of test track operation, including speeds greater than 250 miles per hour.

The Japanese system uses superconducting magnets for levitation which results in a lighter vehicle with a much larger guideway-vehicle gap than the German system. This system has also operated many hours of test track times including speeds greater than 300 miles per hour (although without passengers). Although the Japanese are moving forward with plans for implementation, technical problems still exist with their design, including high magnetic fields in the regions of the passenger compartment.

It appears that we are at a time when the basic research has been completed and much system test data has been collected, but very little system optimization for U.S. needs has been undertaken. We now have the opportunity to look carefully at innovative system concepts which can reduce capital and operating costs while maintaining the maglev performance benefits.

COMMERCIAL IMPLEMENTATION OF APPLIED RESEARCH & DEVELOPMENT

I would like to discuss maglev in the context of the transition from applied R&D to commercial implementation. Traditionally, in the construction business, this transition is a very lengthy process. Construction materials illustrate the difficulties. Even developed materials require a strenuous code approval process. In addition, the expected life may be tens of years, which often requires a very difficult and lengthy test period. Further, construction project teams are reluctant to incorporate new materials until they have been successfully demonstrated because of the risk associated with longlife infrastructure projects having lifetimes of many decades. The costs for research and development then increase as the time for implementation gets longer.

For a construction project which implements the results of applied R&D, the appropriate criterion for judging cost is often the life-cycle cost, which incorporates all of the costs of operation, maintenance, repair and upgrade. When life-cycle costs are used, the benefits of applied R&D can then be realized through simplicity and longer life, as well as through reduced capital construction costs.

On the other hand, construction techniques can advance rapidly, as is occurring with laser-guided machines, for example. Here, the construction work may be often identical with that achieved using conventional techniques, but the construction can be safer, faster and more economical. Similarly, the explosion of computing power has provided the means for implementing rapid advances on the engineering design and services technology side.

Detailed, three-dimensional calculations can be carried out for aerodynamics, dynamic stress analysis, thermal analysis, electromagnetic fields determination, and many other problem areas. Engineers routinely produce computer aided design in three-dimensions. Checks for interferences between components can be automatically undertaken. We can now skip entire generations of scale models because of the accuracy and predictive capability of the analyses and simulations. The simulations are also three-dimensional and time dependent so that not only engineering design but also complex operations can be previewed.

The availability of computing power in desktop units has provided access to powerful project control methods. This includes not only time and schedule controls but also includes materials tracking for steel, pipe, tools, etc.

For U.S. maglev, with a proposed date for initial test track operation in 1999, we must proceed realistically. Special concretes or reinforcing may not be completely proven for the first tests. On the other hand, we should not underestimate the benefits of having the opportunity to create an optimum design based on full systems' considerations. We should recognize that the research, development and testing that has already been completed, and the analysis and modeling capabilities that we are now using will assist in reducing the time required to commercialize a system.

We can best take advantage of the situation using systems analysis to determine the primary cost and performance drivers. In addition the system design, from the start, must be amenable to improvements, extensions, and upgrades. This provides incentives to continue development activities, even while the first systems are generating revenues.

ROLE OF GOVERNMENT

The government, through the National Maglev Initiative, has already taken on the role of initiator and facilitator for the U.S. maglev transportation system. This is both desirable and necessary. This facilitator role must continue through the design, engineering and test phases if we are to successfully implement U.S. "leap frog" maglev. Industry has been active over the last few years, both in research activities and in supporting the National Maglev Initiative. However, government funding will be required if a U.S. system is to be developed.

The government can and should take the lead in establishing a program which is convincingly serious and stable. This, first of all, requires a detailed plan with funding expectations. The Strategic Highway Research Program (SHRP) achieved an important strategic boost, with a five-year planning cycle and expected funding based, in effect, on a percentage of the FHWA budget. The program, in return, has been very innovative and productive.

The risks can be diminished by timely actions in the many areas controlled by the government which have a major impact on participating developers. These include:

Rights-of-way

Maglev is well suited to use existing rights-of-way such as interstate highways or railways. However, these may be essential, not optional. If land acquisition costs are added to the capital and operating costs, widespread commercially profitable maglev systems will be delayed many years.

Safety

The government should move quickly, and in fact has a program underway to set safety standards (or, in some cases, guidelines). Areas include velocity specifications, ride comfort (bank angle, roll rate, acceleration, braking), magnetic field intensity, crashworthiness, evacuation procedures and impact on right-of-way traffic.

Standards

Definition of a guideway standard is particularly critical but standards are also needed for the power system in order to standardize the power voltage, frequency range, current and power factor.

THE NEXT STEPS

The National Maglev Initiative has resulted in procurements initiated for innovative technology assessment and system concept definition studies. Additional studies are planned for market and economics assessments and environmental and health studies. At the conclusion of these studies, it is expected that the viability for U.S. maglev will be more clearly determined. If the results are sufficiently encouraging, the implementation plan calls for completion of a test track with initial operation in 1999.

The timing for the implementation plan is critical for success of U.S. maglev. The present plan proceeds slowly enough to receive significant benefits from testing and implementation of the foreign systems and may be fast enough to avoid being overrun by advanced development of these systems. This assumes there are no major increases in development activities aimed directly for the U.S. market. If competitive development activities occur, it may be necessary to quicken the pace for implementation of a U.S. system. This may pose a dilemma for policy makers. Should they take the steps necessary to permit construction of an imported system - and reap the development benefits of such a system - or should they concentrate on a U.S. technology?

We should not allow the program to lose momentum during the decision period following the reports from these studies. The potential benefits are so substantial that we should expect the results to be encouraging. The program should move smoothly into the next phase, demonstrating stability without interruption. This stable, reasonably funded program is essential for the U.S. to "leapfrog" existing maglev systems.

Gary L. McAllister

Dr. McAllister received his BSEE from Iowa State University in 1961, his MSEE from Purdue University in 1966, and his Ph.D. in Electrical Engineering from the University of Southern California in 1969.

With Sperry Gyroscope Company, he was a Field Engineer working on shipboard radar installations. During his subsequent tour in the U.S. Army, he spent two years working with radar and electronic countermeasure systems.

Prior to joining Bechtel, Dr. McAllister had 17 years of electro-optics experience, with emphasis on theory and experiments in electromagnetic propagation and laser beam quality. During this period, he spent ten years with Exxon in research and technical management, working with high power dye lasers, pulsed power modulators, IR lasers, microwave diagnostic systems, and acoustics. He also spent four years with Maxwell Laboratories, Inc., performing technical research and management on high power gas laser beam and spectral quality.

Dr. McAllister is the Manager of Applied Physics and Civil Programs in Bechtel Corporation's Research and Development organization. He is responsible for R&D's development of new technologies in physics, space and civil areas for implementation by the company.

Mr. VALENTINE. Thank you, Dr. McAllister.
Dr. Barcelo.

STATEMENT OF DR. BRIAN T. BARCELO, DIRECTOR, SERVICE DEVELOPMENT AND MARKETING RESEARCH, AT&T NETWORK SYSTEMS, HOLMDEL, NEW JERSEY

Dr. BARCELO. I thank you, Mr. Chairman.

My name is Brian Barcelo, and I am a marketing director for AT&T Network Systems.

I have been involved with IVHS America and research projects dealing with traffic management systems for several years. And I'd like to make it clear that my remarks primarily represent the views of AT&T, but I believe that most of my colleagues will agree with them.

I think you have a copy of my written statement, and so I am going to skip the motivation for why a company like AT&T would be interested in IVHS and the benefits of IVHS, but I'd like to simply state that I believe that IVHS represents an important new growth opportunity for American industry, especially in the fields of electronics, advanced computer systems, and communications.

What I'd like to do this morning is to give you a sense of where the technology stands and by doing so by citing just a few examples of some of the projects within AT&T that address the needs of IVHS.

Within AT&T we are investigating many opportunities in the IVHS area, namely in traffic management systems, in automatic toll systems, and driver information systems. For example, we are exploring the use of wireless technology, the use of fiberoptic cable, semiconductors, network management in software systems, transmission systems, and computers for the use of the communications infrastructure; that is, the equipment necessary to bring the information from the roadside sensors back to some traffic control center and then back either to roadway signs, driver information systems, personal homes, what have you.

In addition to these systems that really already exist in the telecommunications network, we are also investigating research programs that might be applicable to the traffic management applications. One such project deals with optical character recognition and video compression techniques. These techniques are being adapted in trials for automatic toll identification systems.

The optical character recognition system is currently being tested with Conrail for the purpose of tracking railroad cars and their contents.

Some other of our research is focusing on the deployment of video systems for motion detectors and for surveillance. We have submitted bids and are investigating other bids in all of these products for traffic management systems throughout the United States—many of the States that are represented by your colleagues on the subcommittee.

Another area of interest within AT&T is the automatic toll collection systems. You may recall that in April a New York Times article indicated that seven toll authorities in the New York, New Jersey, and Pennsylvania area have announced a plan to provide a

unified automatic toll collection system for that region. We have been meeting with members of these authorities regarding this project and are investigating several techniques for meeting the requirements of this project. Those include the optical character recognition processes and, in addition to that, two automatic toll collection systems, one from a company in Canada and another one from a company in Italy. The Italian approaches uses AT&T smart cards, which is a card that contains microprocessor in like a credit-card-sized device and stores information associated with the driver of the vehicle for billing, for transaction processing, and other services.

These automatic toll collection systems also present opportunities for future products and services since devices like the smart card can be used to store route and cargo information that can be read—or transmitted, if you will— through roadside monitoring stations. This clearly will allow for commercial vehicles to minimize their stops and reduce their delays, and thus traffic congestion.

Finally, in the area of advanced driver information systems, we are studying the use of wireless communications to transmit route information directly to drivers. The advanced driver information system requires technologies that allow on- board displays to receive information regarding road conditions, traffic accidents, and alternative routing information.

We believe that the intelligent infrastructure greatly enhances the potential for the deployment of a driver information system. However, we believe also that additional improvements in automatic navigation systems similar to those being developed by automobile manufacturers and others—improved and safer user-interfaces such as those that may be required with voice recognition, hexta speech, and head-up displays—will be needed before an advanced driver information system will become widely deployed.

I think if there is anything that research has told us in the adaption of high technology services it is that the systems have to be very simple for people to utilize them.

What I have tried to say is that I think there is considerable progress being made in the developing of IVHS systems; however, there are many factors—technological, economic, social, and political—that will determine whether these systems have widespread deployment. Among these factors include the need to understand end-user requirements, like their willingness to pay, their concerns for safety, human factors, and other privacy kind of concerns. I think this is one of the areas that is really lacking in this area of research—that we don't fully understand what the end user is willing to pay for these new systems.

Secondly, I think we need a well-defined system, architecture, and standards to reduce the risk of development and to encourage the investments in and the deployment of the IVHS systems.

Finally, I think we need more efforts to gain customer acceptance through educational programs and the development of user-friendly systems.

In summary, then, if we are to be successful in this endeavor to implement IVHS systems, we need industry, government, and academic institutions to work together in a joint effort to meet the

challenges of IVHS deployment. In the United States we have made substantial progress in the IVHS arena, but more needs to be done. American industry has the technological capabilities and interest to succeed, but the cooperation of government and industry is essential if the promise of IVHS is to be realized.

Thank you, Mr. Chairman, for your attention. This concludes my prepared remarks. I'd be happy to answer any questions.

[The prepared statement of Dr. Barcelo follows:]

STATEMENT OF

BRIAN T. BARCELO

SERVICE DEVELOPMENT & MARKETING RESEARCH DIRECTOR

AT&T NETWORK SYSTEMS

ON BEHALF OF

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

BEFORE THE

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS

U.S. HOUSE OF REPRESENTATIVES

APRIL 16, 1991

INTRODUCTION

Mr. Chairman and members of the Subcommittee, my name is Brian T. Barcelo. I am Service Development and Marketing Research Director--AT&T Network Systems. AT&T is pleased to have the opportunity to address your Subcommittee on Intelligent Vehicle and Highway Systems (IVHS) technology, a subject of increasing importance to our nation's transportation infrastructure, economy and quality of life.

IVHS is the name given to a broad range of new technologies that could revolutionize the efficiency and safety of both automobiles and highways. IVHS will allow increasing numbers of vehicles to use existing roads more efficiently and with fewer accidents. It holds the promise of reducing the two billion hours a year U.S. commuters spend unproductively in traffic jams. It will also be one of the first vehicle/highway programs that enable us to make a concentrated effort to significantly reduce the number of highway and traffic accidents, rather than trying to improve safety by reducing the number or severity of injuries suffered.

Other nations have recognized the importance of IVHS to their transportation systems, their electronics and semiconductor industries, and their overall economic efficiency. Coordinated industry-government programs are under way in Japan and Western Europe to take advantage of IVHS. These programs combine the

efforts of the central government, highway and local street authorities, academic research and industry, to develop new technologies and to institute nationwide standards.

THE MOTIVATION

As the Subcommittee is well aware, a new initiative has emerged in many quarters toward more efficient use of the nation's highway infrastructure. In February, for example, the Administration expressed support for increased federal spending to improve interstate highways and urged states to make greater use of toll facilities. The trend appears to be toward improved mobility and steadily increasing highway usage, but without widespread construction of new highways.

In like fashion, business people determined to become more productive while traveling have contributed to a dramatic rise in the sale and use of cellular telephones in recent years. As cellular and related technologies are developed and refined, the costs of cellular and other technologies will come down, helping people to work more efficiently and productively without sacrificing convenience and safety.

With this impetus, we can develop a vision of the future that will give us an understanding of what we must do today.

In our view, there are four key areas in which IVHS technologies will make a significant impact:

TRAFFIC MANAGEMENT SYSTEMS: Traffic Management Systems (TMS) will allow better control of local traffic through improved monitoring of current traffic conditions and flexible control of traffic signals. Through TMS, traffic signals will become part of a coordinated control network that can respond dynamically to actual conditions, rather than remaining a collection of separate controls set for average traffic volume. A fully developed TMS would be able to respond quickly to any abnormal conditions, such as those caused by accidents, by altering traffic signal timing and by informing motorists through roadside signs. This response would be accomplished largely under computer control, with little human intervention. Eventually TMS will be integrated with other components of IVHS to communicate driving conditions directly to individual drivers through on-board systems, which can then automatically revise route planning.

ADVANCED DRIVER INFORMATION SYSTEMS: Advanced Driver Information Systems (ADIS) equipment allows traffic and route information to be communicated directly to drivers. Through ADIS, dashboard signals or built-in displays will be used to advise drivers of road conditions, accidents, and alternate-route suggestions, as well as providing them information from electronic "Yellow Pages" business services directories. ADIS also encompasses on-board

systems to locate vehicles through satellite positioning systems and electronic "signposts" along roadways, or by dead-reckoning systems that combine in-vehicle movement sensors with map matching.

AUTOMATED TOLL SYSTEMS: Automated Toll Systems will reduce congestion and improve productivity by allowing for smoother traffic flows. Vehicles will be equipped with transponders that accept electronically sensitive "smart" cards--allowing them to be "read" by an antenna mounted at the toll both. Commuters will be able to pass through tolls at up to 30 mph, thus improving traffic flow. Such a system is already in use on Italy's Autostrada.

COMMERCIAL VEHICLE OPERATIONS (CVO): Many trucking operations, parcel delivery companies and taxis are already taking advantage of the early applications of CVO technology. These applications include automatic vehicle identification and tracking, route planning, and two-way mobile communications. Other CVO features, such as weigh-in-motion sensors (to check truck loads without stopping at weigh stations), automatic vehicle identification, automatic clearance sensing and automatic contents classification, all have the potential to improve efficiency and to lower costs, through reduced delays, less paperwork, and fewer hours devoted to enforcing regulations.

MATCHING TECHNOLOGY TO VISION

Some IVHS technologies currently available and in use include:

Fiber Optic Communications: Fiber optic technology permits simultaneous integration of voice, data and video transmission, with real-time video processing and minimal signal loss. As the cost of fiber continues to decline, it will become more available and more affordable.

Video Surveillance: Video surveillance could be used not only for detection and verification of traffic incidents, but for detecting and verifying toll violators as well.

Network Management Software: Network management software is a critical part of IVHS. It is necessary for configuring any system, as well as for managing performance, security and accounting.

Wireless Communications: Wireless technologies have begun to receive widespread attention and interest for a variety of uses, as briefly noted earlier in the context of cellular telephones, and as further exemplified in the growth of cordless telephones and small satellite dishes. Wireless technologies could have important application in IVHS, where they could provide drivers

real-time information on alternative routes, directions and maps.

High Speed Processing: High-speed processing is necessary for use in toll-lane controllers and video motion detectors, for automatic vehicle identification, for matching accounts and for debiting database information in driver information systems.

All of the above technologies are currently available, but all are not widely deployed.

Evolving technologies that will have important applications in IVHS include:

Expert Systems: Expert systems will vastly facilitate the collection, processing and storage of traffic and roadway information, and help assure its reliability, accuracy and consistency. Artificial intelligence and expert systems will provide such information from monitoring systems, sensors, police reports and construction activities on a real-time basis.

Speech Recognition: Speech recognition technologies could be used by drivers for hands-free sending and receipt of information. By affording drivers instantaneous information on traffic and highway conditions, alternative route information and the opportunity to interact with simple speech commands, this technology could create a safer and more comfortable driving environment.

Packet Cellular: Packet cellular technology offers highly efficient use of available bandwidth and it is cost effective. In a packet cellular format, many short messages--such as latitude and longitude, velocity and compass readings--can be handled simultaneously and delivered to drivers for use in navigational and guidance systems.

KEY CHALLENGES FOR IVHS

Many factors--technological, economic, social and political --will determine the feasibility of any wide deployment of IVHS in the private sector. The following deserve mention:

1. Better understanding of end-user requirements;
2. Developing, integrating and deploying technological solutions; and
3. Attaining growing customer acceptance.

UNDERSTANDING END-USER REQUIREMENTS

More market research with drivers and other travelers would help determine:

- Their willingness to pay for IVHS services;
- What services IVHS should provide, to be useful to motorists and travelers; and
- What human factors are most important in IVHS.

Those designing and building IVHS will also need to have factual, up-to-date information on the public's concerns on such fundamental issues as privacy, safety and the environment. Research on these issues is essential for developing an IVHS plan that will gain widespread public acceptance.

DEVELOPING TECHNOLOGICAL SOLUTIONS

A well-defined IVHS architecture is fundamental for solving some of our current highway and traffic problems and is essential to stimulate private-sector participation as well. Only through a well-defined architecture will companies be able to provide cost-effective technologies, equipment and services to the public and establish accepted solutions to which companies can adapt their plans in the IVHS market.

Related to the need for IVHS architecture is the need for IVHS standards, which will provide benefits to both IVHS users and providers. Standards help reduce risk, by removing technological uncertainty and by helping to focus development efforts.

Once the architecture is set and standards have been developed, companies interested in competing for some aspect of IVHS can determine what products or services they possess that could be part of IVHS and what technological capabilities they

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have that could be evolved and integrated into new IVHS products or services.

ATTAINING ACCEPTANCE

Customers will more quickly and easily recognize the value and convenience of IVHS if well-planned educational programs are used to introduce this system to the public. The easier something is to use, the better people like it. Through field trials and demonstrations of IVHS equipment and services, for example, customers will be able to see its benefits: reduction in traffic delays, safer and less stressful travel, etc. Knowledge gained from such trials can also be used to develop and improve additional products and services to make traveling more convenient.

These are some of the issues that must be addressed before a successful IVHS plan can be implemented. It is AT&T's view that the private sector already has the technology or can develop the technology needed for IVHS.

SUMMARY

Rapidly increasing highway usage is making IVHS a national imperative. While more and more of the technological pieces fall into place, architectural design and standards must be agreed

upon, and continued research must be done to determine specific user needs. Gaining customer and public acceptance are tasks that will require more than a vision, but the need is significant and there are many private-sector suppliers ready to compete for a share of the emerging market.

The development and deployment of new technologies could be speeded by cooperation of federal and state governments, education and industry.

ATTACHMENT

In addition to our own written statement on IVHS, AT&T asks the Subcommittee's approval to append the following IVHS statement, which was recently developed by the National Advisory Committee on Semiconductors (NACS). NACS believes that IVHS is one of several important emerging markets for U.S.-made semiconductors, where close cooperation between industry and government are critical. The NACS paper that follows provides a good overview of the IVHS market and makes several general recommendations on ways to stimulate the growth of IVHS.

Thank you, Mr. Chairman.

THE INTELLIGENT VEHICHLE/HIGHWAY SYSTEM:

An Overview

Prepared by the National Advisory Committee on Semiconductors

April 16, 1991

THE INTELLIGENT VEHICLE/HIGHWAY SYSTEM

INTRODUCTION

Traffic congestion, poor highway safety, and the environmental damage done by the Nation's reliance on automobiles and trucks are serious problems that are getting increasing attention from transportation officials and private industry. Constructing more roads might help to alleviate some of the congestion problems, and could have a limited impact on the number of traffic accidents. But road construction, especially in urban areas where traffic congestion is the most severe, is becoming increasingly difficult and expensive. One alternative solution receiving increasing attention is to improve the quality of highways and the vehicles that use them.

The Intelligent Vehicle/Highway System (IVHS) is the name given to a broad range of new technologies meant to revolutionize the efficiency and safety of both automobiles and highways. IVHS will allow increasing numbers of vehicles to use existing roads more efficiently, and with fewer accidents. It holds the promise of reducing the 2 billion hours a year U.S. commuters spend unproductively in traffic jams. It will also be one of the first vehicle/highway programs to make a concentrated effort to significantly reduce the number of accidents, rather than trying to improve safety by reducing the number or severity of injuries suffered.

IVHS is also an excellent example of a new, potentially high-volume market for U.S. semiconductors. Along with other "revolutionary" markets that open broad new business opportunities for semiconductors, such as broadband communications and advanced displays, IVHS will stimulate growth and drive technologies throughout the next decade and beyond. In order to maintain a competitive position in the world semiconductor and electronics markets, U.S. firms must be strong participants in these new markets. Failure to do so will threaten to prevent U.S. semiconductor firms from achieving the economies of scale in manufacturing, and especially technology development, that are central to staying at the state-of-the-art. Failure will also deprive U.S. industry of the advantages of the technological progress that, once developed for IVHS, could be transferred to other unrelated products and services.

Other nations have recognized the importance of IVHS to their transportation systems, electronics and semiconductor industries, and to their overall economic efficiency. Coordinated industry-government programs are underway in Japan and Western Europe to take advantage of IVHS.[1] All of these programs combine the efforts of the central government, highway and local street authorities, academic research and industry to develop new technology and institute nationwide standards. Some projects have already begun the deployment of IVHS technology in systems like the automated toll collection

[1]The major programs include the Road/Automobile Communication System (RACS) and Advanced Mobile Traffic Information and Communication System (AMTICS) in Japan, and the PROgraM for European Traffic with Highest Efficiency and Unprecedented Safety (PROMETHEUS) and the Dedicated Road Infrastructure for Vehicle Safety (DRIVE) in Europe.

system on the Italian Autostrada. Such efforts are only at the earliest stages within the United States.

IVHS products are in their embryonic stages. No technology is dominant and no country has created unbreachable standards. It is a market in which United States manufacturers could develop and control significant market share. But, the need for action by industry and support from government is urgent because the opportunity will only be available for a limited time.

THE IMPACT OF IVHS ON SEMICONDUCTORS AND ELECTRONICS

The Intelligent Vehicle Highway System represents an important market for semiconductors for many reasons. It will be a large, diverse market where many of the potential semiconductor components purchasers are domestic companies. In addition, it will act as a technology driver for semiconductor components in new electronics markets, such as low-cost satellite receivers, radar-based collision avoidance systems and a variety of sensors to monitor vehicle operations. Because many of the semiconductor components will be incorporated into high-volume products (automobiles) there will be emphasis on efficient, low-cost manufacturing, and a need to provide flexible manufacturing capable of supplying high volumes of new products quickly.

The electronic content of the latest automobile models is increasing rapidly. In 1984, the electronic content of Ford automobiles averaged $585. By 1992 the average is expected to rise to $1350, and rapid increases are expected throughout the 1990's.[2] Already, the German luxury auto maker BMW reports that electronics accounts for 20 percent of their vehicles' cost.[3] The total world automotive electronics market is expected to grow to at least $28 billion annually by the year 2000.[4] Much of the increase in automobile electronic content will come from systems involved with IVHS. But, the size of the IVHS market for semiconductors and electronic systems comes from more than just the products designed into new automobiles. The market will include products that include sensors and communications equipment distributed within the highway system, computer and communications equipment at the control centers that manage regional traffic, and the communications systems that form the control network. The technologies pursued will range from advanced chip manufacturing techniques to image processing, machine vision, speech recognition, expert systems and advanced materials.

Another important factor in the IVHS market is the geographic location of the potential buyers of the electronics used in new systems. Since all of the major U.S. auto makers are expected to be large purchasers, domestic semiconductor firms (including captive producers associated with the auto makers) will have an unrestricted opportunity to sell into the market. Likewise, the Federal government, as well as State and local governments, will be purchasing electronic systems as they invest in the new highway

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[2]This estimate comes from a University of Michigan Delphi Study, reported at 1990 Convergence: International Congress on Transportation Electronics.

[3]"BMW drives electronics in-house," Electronic Engineering Times, September 24, 1990, p.20.

[4]*Report to Congress on Intelligent Vehicle-Highway Systems*, U.S. Department of Commerce, (DOT-P-37-90-1), March 1990, p.43.

infrastructure. Early success in these domestic markets could be used as a springboard for U.S. semiconductor firms to participate in the international market for IVHS components.

IVHS will demand many different products from electronics suppliers, using a variety of different semiconductor technologies from many suppliers. Much of the demand will be for silicon integrated circuits, but compound semiconductors will also be needed for satellite reception and radar systems, and optoelectronic components will be used in communications systems. Also in high demand will be advanced displays, optical mass-storage systems and sensors. The silicon products used will include microprocessors (with their associated memory and support chips), signal processors, application specific integrated circuits (ASICs), non-volatile memories, and communications protocol circuits. The revenues from the sale of these products will support additional R&D and capital equipment investment in the U.S. semiconductor industry. This investment will be used to develop new IVHS products, and it will be used to advance the state-of-the-art in semiconductor technology. The U.S. must participate sufficiently in high volume markets, such as IVHS, to maintain the high levels of investment needed for a competitive position in semiconductor technology.

THE COMPONENTS OF IVHS

The many capabilities of a comprehensive IVHS can be grouped into four broad categories that have substantial overlap and interaction. Many of the IVHS technologies can be developed and deployed independently, but the overall impact on the transportation network is increased as more of the individual systems are deployed and can work together. The following sections outline the major IVHS market segments, indicating some of the potential features and benefits in each area.

Advanced Traffic Management Systems

Advanced Traffic Management Systems (ATMS) will allow better control of local traffic through improved monitoring of current traffic conditions and flexible control of traffic signals. Through ATMS, traffic signals will become part of a coordinated control network that can respond dynamically to actual conditions, rather than a collection of separate controls set for average traffic volume. A fully developed ATMS would be able to respond quickly to any abnormal conditions, such as accidents, by altering traffic signal timing and by informing motorists through roadside signs. This response will be accomplished largely under computer control, with little human intervention. Eventually ATMS will work with other components of IVHS to communicate driving conditions directly to individual drivers through on-board systems that can revise route planning.

Early efforts to provide ATMS are now being introduced in many cities, implemented with available technology. While these systems are limited in scope, they do provide some encouraging evidence of the system's effectiveness. Studies have been able to measure significant reductions in travel times, accidents and air pollution in locations that have implemented trial ATMS. The first systems have generally concentrated on a few arteries where congestion is particularly severe. Some of the systems meter freeway on-ramps, others vary the timing of traffic signals. As more advanced systems are introduced, the systems will become more comprehensive, both in terms of the area covered and the

techniques applied. Eventually ATMS will go beyond reacting to increased congestion, and begin to predict problems and take action to avoid congestion. In addition, the current road's ability to carry traffic may be increased sufficiently by implementing ATMS to avoid or delay building additional roads. This is particularly important in urban areas where the costs of building additional roads are very high.

One early use of ATMS will be automatic vehicle identification and fare collection for toll roads and bridges[5]. Each vehicle would be equipped with an electronic device that would allow it to pass toll booths without stopping, while the toll is deducted from an electronic account. Other possible applications of ATMS include vehicle identification to retrieve stolen vehicles and monitors for hazardous materials transporters.

A complete ATMS starts with a traffic surveillance and detection infrastructure. In addition, there must be a central location to analyze the information and determine what changes are required to control the traffic. Third, ATMS must include traffic controls (traffic lights, lane restriction controls, freeway ramp metering systems, etc.) that can respond to the control center. Last, the whole system must be tied together through a communications network. The ATMS infrastructure gathers the raw data about road conditions through loop sensors in roads, video cameras at strategic locations, video motion detectors using image processing algorithms and, if necessary, eyewitness accounts from police and emergency crews. The ATMS communications infrastructure could become an important application for fiber optics-based broadband ISDN communications, as data, video and voice information is transmitted over a common network to a regional traffic control center. Eventually, as more cars are equipped with IVHS equipment, information about traffic conditions could be collected directly from vehicles travelling on the roads, in addition to being collected from traditional loop sensors and video cameras.

Once the traffic information is brought together through a single network, the patterns can be analyzed, compared to normal conditions, and examined for abnormal incidents. The analysis can be done by system operators in the control centers or automatically by computers using specially developed expert systems, incident detection algorithms, or other software. Traffic trends can be examined and preventative control measures can be taken to prevent congestion from developing into severe problems. In addition, accidents can be identified, and the police can be notified more quickly than without ATMS. The importance of the network connecting the entire system cannot be overemphasized. The real power of ATMS can be realized only when many traffic control systems work together in a coordinated program, implementing control strategies that improve traffic flow for the entire road network.

ATMS is expected to be one of the earliest IVHS elements implemented as cities move toward advanced traffic controls. The other elements of IVHS, such as advanced driver information systems and automated vehicle control systems, will rely on the information collected by ATMS in order to plan trips and suggest new routes to avoid congestion.

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[5]Field trials of automated toll collection systems are now taking place.

Commercial Vehicle Operations

The Commercial Vehicle Operations (CVO) segment of IVHS is intended to increase the efficiency of the nation's transportation systems for commercial carriers. Because of the high level of competition among commercial carriers, CVO technologies are already being implemented to reduce operating costs. However, CVO will not only help carriers, they will also assist state and local regulators, and improve general road safety.

Many trucking operations, parcel delivery companies and taxis are already taking advantage of the early applications of CVO technology. These applications include automatic vehicle identification and tracking, route planning, and two-way mobile communications. Other CVO features, such as weigh-in-motion sensors (to check truck loads without stopping at weigh stations), automatic vehicle identification, automatic clearance sensing and automatic contents classification all have the potential to improve efficiency and lower costs through reduced delays, less paperwork, and fewer hours devoted to enforcing regulations.

Even though many of the CVO technologies being implemented by commercial carriers require substantial capital investments, their practical value is shown by the growing number of installations. A number of trucking companies are using sophisticated satellite-based tracking and dispatching systems. If IVHS systems were standardized, both for commercial and private vehicle applications, the increased number of systems installed would provide economies of scale in manufacturing and development so that users' costs would fall sharply.

Trucking fleets provide excellent opportunities to experiment with new IVHS features and technologies. Each commercial fleet includes a large number of vehicles and much of the existing IVHS capital equipment and personnel training could be used to advantage. Also, commercial carrier operators and owners generally are more knowledgeable (and in some instances more dependent) on the productivity advantages of IVHS, and might be more inclined than the general public to enthusiastically participate in a field trial.

Advanced Driver Information Systems

Advanced Driver Information Systems (ADIS) equipment allows traffic and route information to be communicated directly to drivers. Through ADIS, dashboard signals or built-in displays will be used to advise drivers of road conditions, recent accidents, route suggestions and electronic "Yellow Pages" business services directory information. ADIS also encompasses on-board systems to locate vehicles through satellite positioning systems, electronic "signposts" along roadways or by dead reckoning systems combining in-vehicle movement sensors with map matching.

ADIS will require several new electronic systems to be added to vehicles. First, a display will be required to communicate with the driver. This is expected to be a flat panel display, as medium-sized color units become available at low prices. Flat panel displays are preferred because they are rugged enough to deliver reliable performance in a car's difficult environment. They are also flexible enough to allow a wide variety of information

to be displayed at different times. Second, a communications module will be required by ADIS to receive information from central traffic control facilities, and to transmit traffic conditions in return. There are a number of available technologies that could be used, including variations of digital cellular transmission. It is expected that map information would be carried within cars, stored in compact disc form, therefore a computer system to retrieve the information, calculate positions and determine routes must be included in ADIS. Finally, to determine a vehicle's current location, an electronic system capable of direct communication with global positioning satellites or other positioning aides must be developed. Although each of these requirements can be met with existing electronic technology, it is expected that combining all of the systems into an affordable addition to a personal automobile will require a substantial development effort. Thus, ADIS will be gradually phased into widespread operation.

ADIS will include several functions to decrease the time drivers spend in their cars, reduce fuel consumption and air pollution, and make route planning more reliable. These features could, for instance, reduce the 6 percent of all driving that is estimated to be caused by incorrect choices in routes. Route planning could be one of the early features of ADIS to be implemented, since the systems required for the task could be self-contained in each car and not rely on additions to the highway infrastructure. In addition to planning a route, the systems could estimate the time required for the trip, the distance, and travel-related expenses. One proposed system would store route maps, business services directories and tourist information on compact discs. While this system would not require additions to the highways infrastructure, it would require that the discs be exchanged periodically to keep the information up to date. In early implementations of ADIS an on-board computer could suggest routes prior to beginning a trip. Once the highway infrastructure becomes more advanced and vehicles begin to communicate with central traffic management facilities, the system could dynamically alter routes to avoid accidents or congestion due to construction, and could prompt drivers for upcoming turns.

Not all ADIS systems will rely on in-car communication. ADIS also includes systems like improved signs and radio broadcasts that can relay different current road conditions to motorists. These features would be available to all drivers--not just those who have ADIS-equipped vehicles.

Improved safety is another thrust of ADIS. Eventually, the systems could show traffic signs on dashboard displays, warn drivers of upcoming sharp curves and narrow bridges, and even monitor the driver's performance to warn sleepy or drunk drivers.

Automated Vehicle Control Systems

Some of the most ambitious goals of IVHS are connected with Automated Vehicle Control Systems (AVCS). These systems would take over some of the driver's responsibilities, both in routine situations (e.g., driving cars at high speed and close intervals to improve road capacity and safety) and in unusual situations (e.g., automatic braking to avoid accidents). The degree of intervention by the systems ranges from simply providing drivers with additional information to complete control of a vehicle's speed and steering.

The two major thrusts of AVCS are improved roadway efficiency and improved safety. Improved roadway efficiency can be achieved by allowing more vehicles to use

existing road through increased automated controls. With AVCS it will be possible to reduce the distance between vehicles, both front to rear and side to side. The California Department of Transportation (CALTRANS) believes that when vehicles are under automated control, lane widths can be reduced from 12 feet to 8 feet. That would mean a 50 percent increase in the number of lanes in any existing roadway. Such improvements are required as long as the volume of traffic is growing more quickly than the roadway network.

The second major goal of AVCS is improved safety and more effective accident prevention. AVCS will include obstacle avoidance radar to provide additional warning time for potential collisions, to indicate the presence of other vehicles in blind spots and to warn drivers of a loss of alertness. These systems could pay for themselves if they can prevent a fraction of the $100 billion in economic losses expected annually from automobile accidents by the year 2020. These savings will directly benefit motorists through lower medical bills and less property damage, and they will indirectly benefit drivers through lower insurance premiums.

Like the other components of the IVHS system, AVCS includes both stand-alone functions that operate without any interaction outside of the vehicle, and other functions that must be integrated into an overall system. Many of the AVCS features must work closely with Advanced Driver Information Systems in order to warn the driver of dangerous situations and conditions. The simplest AVCS features are beginning to be common in new cars. These include anti-lock brakes and cruise control. An additional, more sophisticated group of AVCS features require some interaction between vehicles and the highway, including intelligent speed controls that work in concert with other vehicles on the road and "platooning" groups of cars on special freeway lanes. The most advanced AVCS features, including "automated highways" are probably 30 years from service, however. Before these features are implemented there must be a gradual evolution in the aid given to drivers.

While the implementation of AVCS is propelled by the potential to save lives and prevent billions of dollars in property damage, the challenges to successful implementation are large as well. First, the information needed by drivers is diverse, and it will be difficult to design systems that meet everyone's needs. Second, to provide the most advanced AVCS features, there will need to be large investments in the highway infrastructure which must be coordinated between Federal, State and local governments, and the IVHS product producers. At the same time, there will be little incentive for auto owners to pay for AVCS equipment in their cars until the infrastructure is in place which make the systems useable. Third, for those systems where a substantial degree of vehicle control is assumed by AVCS there are many product liability issues that must be settled. Even though thousands of people are killed each year in accidents resulting from human drivers, there could be huge liabilities for companies producing the AVCS equipment responsible for *any* fatalities.

THE BENEFITS OF IVHS

The potential benefits of IVHS technologies can be grouped into four broad categories. First, driving safety will be improved. This will lead to fewer accidents, lower economic losses and a reduced number of lives lost on the Nation's highways. Second, congestion will be reduced and travel times shortened. Third, IVHS is expected to lead to a

significant reduction in air pollution and fuel consumption. And fourth, the efficiency of the Nation's commerce will be improved, leading to higher productivity and enhanced competitiveness.

One major premise of IVHS is its ability to make major improvements in traffic safety. Currently, traffic accidents claim about 47,000 lives annually in the United States. In addition, there are approximately 150,000 permanent injuries, 1,650,000 recoverable injuries, and $70 billion in lost wages and direct costs each year. As roads become more congested in future years, these totals are expected to rise. Many IVHS features are aimed at preventing accidents, and as the new technologies achieve increasing penetration in motor vehicle fleets, the accident rate can be expected to be reduced. Even relatively simple IVHS techniques, such as freeway entrance ramp metering[6], have been shown to reduce accidents by 20 to 40% along congested urban corridors. Other studies indicate that half of all accidents could be prevented if drivers had an additional 1/2 second warning.[7] IVHS technologies are expected to warn drivers if they are beginning to drive off the roadway, warn when other vehicles are in blind spots, check for stopped traffic or other obstacles ahead, improve braking effectiveness, and enhance vision at night or under adverse driving conditions. These systems could provide the additional warning necessary to prevent a substantial fraction of the accidents that are accepted as routine today. Eventually, as more driver control functions are assumed by IVHS, safety could be improved to unprecedented levels. The money saved annually by improved safety could easily justify the deployment and maintenance cost of IVHS systems.[8]

Another major objective of IVHS is to reduce traffic congestion and travel times. Through route planning, motorists could avoid wasting time following the wrong roads, and could also avoid the distractions associated with trying to find their way while travelling over unfamiliar routes. Traffic management systems within an IVHS network can also significantly reduce congestion by adapting traffic signals to increased auto volumes. As IVHS becomes more sophisticated, drivers will receive up-to-date information on driving conditions, and suggestions of alternate routes to avoid delays. These improvements will directly benefit motorists and commercial carriers by reducing the amount of unproductive time they spend on the road, and motorists will have indirect benefits through reductions in accidents caused by congested conditions and driver frustration.

An additional major benefit of IVHS will be reductions in air pollution. Whenever travel times are reduced and congestion is relieved, air pollution is decreased. Cars that are stopped on a freeway, waiting for an accident to be cleared, continue to burn fuel and contribute to air pollution. The same is true for automobiles that are waiting for traffic signals that are not optimized for the current conditions. Significant reductions in this waste could be gained, even from fairly modest investments in IVHS. Without IVHS, the gains made over the past two decades in vehicle emissions, due to pollution control equipment on new cars, will begin to be reversed as a result of increases in the number of vehicle miles driven.

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[6]Freeway ramp metering controls the flow of cars onto entrance ramps through roadside traffic signals.
[7]*Intelligent Vehicle Highway Systems: Operational Benefits*, Final Report of the Working Group on Operational Benefits, Mobility 2000, March 1990, p.10.
[8]Mobility 2000 , and industry and government group promoting increased development and deployment of IVHS technology, estimates over 11,000 lives, 400,000 injuries and $22 billion in costs likely could be saved each year by 2010. See ibid., p.14.

The fourth benefit of IVHS, improvements in the efficiency of the economy due to better transportation systems, is harder to quantify than the previous three benefits. Likewise, the enormous benefits of the interstate highway system were not known in detail before its construction. What is clear, however, is that IVHS will allow more efficient transportation of goods around the country, lowering one component of product costs, and incrementally improving the competitiveness of U.S. goods and services. It also has the potential of providing jobs and economic growth through the U.S. firms that are providers of IVHS products and services.

RECOMMENDATIONS

Industry, with support from government, must work toward the implementation of a comprehensive intelligent vehicle/highway system within the United States. Much of the development cost, and product planning will be the responsibility of industry, which stands to profit by providing IVHS products to consumers. However, there are many reasons to involve government in both the planning and the funding for IVHS development. First, the government has traditionally built and maintained the Nation's road network. Because a comprehensive IVHS will require substantial investments in the government-owned and operated highway infrastructure, the government must be a willing partner in technology development. Second, the government has a legitimate role in improving highway safety. Improved safety, such as that promised by IVHS, has a positive economic impact that is not easily incorporated into private business investment decisions, although the benefits will be widespread among IVHS users. Likewise, the improved air quality resulting from IVHS is a social benefit that should be encouraged by government involvement in IVHS programs.

Therefore, industry and government must work together to:

- **Encourage cooperate efforts to set a national agenda for the development and deployment of IVHS, and to promote the coordination of private and public IVHS efforts.** IVHS deployment goals should be set, and a specific strategy formulated to achieve them. Overall coordination of a nationwide effort is one of the most pressing issues for the advancement of IVHS in the United States. The appropriate division between public and private responsibilities must also be determined.

  In addition, industry and government must work to streamline the way they work together, in order to provide a more efficient and practical way to communicate program requirements and proposed services. The difficulties of working with various government agencies should not become a barrier to the advancement of IVHS.

- **Increase funding for R&D on all aspects of IVHS.** Increased R&D is required for a broad range of activities, including software systems, sensors, image processing, positioning systems, human factors modeling and standardization. Industry and government should consider consortia to spread the development costs of pre-competitive research, and standards setting.

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Participation by the academic community in research and development should be pursued.

- **Encourage improvement in the highway infrastructure by providing incentives in Federal highway funding for the installation of IVHS.** Any existing limitations on the use of Federal grant for IVHS should be eliminated, and future grants for urban highway improvements could be made contingent on the gradual deployment of IVHS. Such a commitment to upgrading the highway infrastructure would encourage vehicle manufacturers to develop and install more advanced IVHS equipment in their products.

- **Support extensive field trials for IVHS.** Large scale field trials are essential to improve IVHS technology, determine the best technology and products to provide useful information to drivers, and to assess the benefits that can be achieved from IVHS. Again, a partnership between industry and government (federal, state and local) is essential since each will have major roles in the eventual widespread deployment of IVHS technology.

- **Establish nationwide standards for IVHS.** The effectiveness of IVHS systems, and their cost to the public, will be adversely affected if multiple, incompatible systems are used throughout the country. This is especially true as the interaction between vehicles and central traffic management centers increases in the later stages of IVHS deployment. Standards are also important internationally to protect the interests of U.S. equipment producers. The U.S. Government should take a lead role in international standards setting forums to insure that the best system, most cost effective system is implemented.

- **Settling the outstanding product liability questions involved in IVHS deployment.** Industry should work with the Congress and other interested parties to provide equitable limitations on the liability of private and public IVHS suppliers and operators.

Mr. VALENTINE. Thank you, Dr. Barcelo.

We thank all of you.

Dr. Hobieka, you mentioned, I believe, in your prepared statement, the fact that the United States lags behind Japan and several European countries—I guess that means perhaps certainly Germany—in intelligent vehicle technology. What we have when we talk about this IVHS and when we talk about maglev and the future and R&D and the practical applications, aren't there basic differences between say a country like Japan and a compact series of islands and a vast, vast ocean-to-ocean nation in its attitude toward these technologies? Aren't there two different arenas, two different ball games, two different psychologies that would put us at a disadvantage, per se?

Dr. HOBIEKA. Yes. I think if I can understand your statement, it is the fact that there is more pressure in Japan and maybe in certain European countries to come up with more technology in order to solve some of their congestion problem because they don't have the space.

Mr. VALENTINE. Not only that—and I just pulled figures out of the air—with 1,000 miles of the system you could tie the country together. With 1,000 miles of the system in the United States all you'd do is create regional problems. They got it and we ain't.

Dr. HOBIEKA. This has been a phenomena in the United States that we do really rely on space to solve some of our transportation problems. We keep moving outside the urban congestion area. We go according to some urban sprawl and we keep sprawling. But really it is challenging, our city structure and our ability to provide services. As you move out, the burden of trying to keep providing services and infrastructure, not only including highways, but all other infrastructure becomes more burdens. I think we are reaching the point that that sprawl is, in a way, eating up our ability to really keep up that infrastructure and more or less maybe to revise that concept is that, yes, we shouldn't depend upon really our abundance of space as a way to really say that that's the way to go in the future. I think we have to limit that idea and really see in its context what it is doing to our cities and ability to really repackage that city environment in a way that can help not only the movement by highway, but movement by transit and other things like my colleagues are saying in terms of maglev and other things.

Mr. VALENTINE. I suppose the national geographic differences internally which I referred to would—of course, we cover a lot of different areas. I remember years and years ago when the exchange student visiting living in the home of a friend of mine in North Carolina—this was at a time when we had—I don't know how to say it, but we had developed finally a national telephone system without having to go through the operator that you used to in Mayberry. When it was easier to call from coast to coast—and this person was an exchange student from the Netherlands. She said, "Oh, we've had that at home for a long time." When you think about being able to communicate the call through Holland with the telephone, and they should have had it in the beginning — anyway, we are given to understand, Doctor Hobieka, that Mitsubishi has a smart car that can sense when a driver makes an abrupt turn or some maneuver at a high speed and it will act to reduce

the power of the vehicle. Are you familiar with that sort of thing? And, in your opinion, what is the value of that worth the price of the technology?

Dr. HOBIEKA. This is part of this intelligent vehicle highway system. It is called collision avoidance. Some of it are thinking of doing it through radar braking. In fact, it is similar to—if I want to put it simply, it is like your automatic cruise control. Instead of having it at a fixed speed, it would be a variable cruise control that detects in front of you certain vehicle and it changes your speed automatically, and so you don't have to keep readjusting your cruise control. These are some of the things might be happening really in not too distant future. Some people are thinking that that will appear in the United States market in a couple of years.

Mr. VALENTINE. I guess I'm so much of an old fogey that I would be much better satisfied with a system that would detect the problem and relay that information to the driver and let him decide whether he wanted to speed up or slow down.

But, anyway, Dr. McAllister, the maglev technology, as I understand it, was ruled out in the discussion or the planning about the transportation system between Las Vegas and Anaheim, California. Can you tell us why maglev did not survive that competition?

Dr. MCALLISTER. Actually maglev was the one that was proposed for that. In the early competition the high-speed rail I believe is the one that dropped out in the early competition.

Mr. VALENTINE. Well, maybe I phrased it differently. Was the maglev proposal withdrawn?

Dr. MCALLISTER. I'm really speaking now for the other side of the house, which is the commercial side of the house. What was put forward two months ago now was changes in the proposal. That's all that I'm aware of. As you know, I'm on the R&D side—

Mr. VALENTINE. Yes.

Dr. MCALLISTER.—and so I should not speak for the project side. I would be happy to get you an update. I would be happy to get you an update on that.

Mr. VALENTINE. If you would, because we understand they withdrew the proposal.

[The information not available at press time.]

Mr. VALENTINE. Dr. Barcelo, are there any plans or concepts for a complete automated highway system that you know of where technology takes over and the driver just sits back and takes it easy?

Dr. BARCELO. Mr. Chairman, that's an interesting question. I think that maybe in the very distant future that kind of a concept may be possible. I mean, I'm thinking of science fiction writers who dream up a lot of things. I don't think that in the near—

Mr. VALENTINE. I hope that when that comes there is a sufficient warning to the rest of us, because I can just— that worries me, you know. You got tapping on that machine to be sure that it works right. When we make that much progress, that cat is moving down the highway at 80 miles an hour and sitting back having a cool beer and smoking a cigarette or something like that, you know, looking out the rear view mirror looking at television, I want to be sure I'm on the other road somewhere.

Dr. BARCELO. I agree with you. I don't think that that kind of a system is any time in the near future. I think there are a lot of technologies that are being applied to the problem of traffic congestion, and I think we shouldn't lose sight of the value that it can provide consumers as well as businesses, but I don't really think there is a system, at least that I know of, that would be so totally automated any time in the near future that didn't require any sort of driver interference or interaction.

Mr. VALENTINE. Well, we would like to submit questions. We've whittled down here and taken a lot of time. I've even lost my ranking Republican member, so I suppose it is time to wind this down.

We do appreciate what you do, the contribution that you make, the time it took for you to prepare yourselves and to come and share this information with us. And I want to say also finally that I would not like anything that I have had to say to be interpreted as meaning that we should not attempt to reach out. Of course we should go everywhere our intelligence and tax dollars can lead us, and we ought to know everything that there is to know about these magnificent areas that you gentlemen are familiar with.

Thank you very much. We might receive some questions, and if so we would appreciate it if you would let us have the answers.

The subcommittee stands adjourned.

[Whereupon, at 12:04 p.m., the subcommittee adjourned, to reconvene at the call of the Chair.]

APPENDIX

THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

January 22, 1991

STATEMENT OF THE SECRETARY OF TRANSPORTATION

When we issued the Statement of National Transportation Policy in March 1990, it was the first step in a process designed to bring our transportation system into the next Century. A key part of this process was to take full advantage of new and emerging transportation technologies to help improve our current systems, and to provide new options for improved transportation services.

This statement of research policy represents a key follow-on step in this process. It expands on the principles set forth in the policy statement and describes how they apply to the formulation of the Department of Transportation's research and development (R&D) program. Equally important, it sets forth priority areas for research in the transportation sector over the next several years, building on the directions set in the policy statement.

Within the Department we have already used the principles and priorities in the policy statement to evaluate FY-1992 budget proposals, and we will be using it in formulating future budgets and programs. The Statement of National Transportation Policy creates a framework that allows the Department to adjust and respond to changing problems and challenges. This policy statement for research and development is designed to provide the same flexible framework for the Department in technical areas.

Only the cooperative involvement of the entire transportation community -- Federal agencies, state and local governments, the private sector, and all the others -- can deal successfully with the problems we are facing. The cooperative relationships we forged during the development of the policy represent the start of a new era in transportation technical programs. I welcome your involvement in this exciting process.

Samuel K. Skinner

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A STATEMENT OF
U.S. DEPARTMENT OF TRANSPORTATION
RESEARCH AND DEVELOPMENT POLICY

EXECUTIVE SUMMARY

This document is designed to provide a broad policy base to support structuring a sound and effective Departmental research and development (R&D) program. It is also to serve as a conceptual checklist for program selection and design, both for individual operating administrations in development of their R&D programs, and at the Departmental level in the crossmodal review of submitted budgets.

The U.S. Department of Transportation's R&D program is one mechanism to help carry out the Departmental mission. The Statement of National Transportation Policy (the NTP) issued in March 1990 provides critical strategic guidelines for the Department in executing that mission. The NTP presented a set of six key themes which the Department's programs and activities serve. Each of these has specific implications for the conduct of research projects:

1. Maintain and expand the Nation's transportation: will be supported by projects to improve the capacity, condition, and utilization of existing transportation systems and infrastructure.

2. Foster a sound financial base for transportation: will be supported by projects to develop innovative approaches to public, joint, and private funding of transportation, assess existing mechanisms for funding transportation, and promote private sector investment.

3. Keep the transportation industry strong and competitive: will be supported by projects to promote competition in and across modes, reduce system costs and foster the Nation's international competitiveness.

4. Ensure the transportation system supports public safety and national security: will be supported by projects to reduce the risk and severity of accidents in individual modes and across modes, and maintain the security of the Nation, its transportation system, and that system's users.

5. Protect the environment and the quality of life: will be supported by projects to minimize the adverse impacts of transportation operations and facilities, conserve energy and protect natural resources, and enhance transportation access and quality of life for all.

6. Advance U.S. transportation technology and expertise: will be supported by projects to develop, evaluate, and permit realization of technological advances in transportation operations, management, data and planning.

R&D undertaken by the Department to

address these concerns should be shaped by several key principles for program development:

1. It should be responsive to the directions established and the commitments made in the Statement of National Transportation Policy.

2. It should consider the potential users and problems involved in applying R&D outputs in program selection and design.

3. A portion of the research program should be directed to supporting the Department's operational missions.

4. A portion of the research program should be directed to improving the quality of transportation decisions in the Department and the transportation community.

5. A portion of the research program should be directed to stimulating action by the private sector, particularly in demonstrating the market for new technologies.

6. The program should balance meeting short-term needs and providing longer term options for system development.

7. The program should focus on projects that are wise investments, i.e. whose potential benefits are greater than their costs.

8. The program should include mechanisms to manage research programs effectively and prevent duplication.

9. The program should provide for mechanisms to promote dissemination and application of its products.

This document also provides detailed design criteria for the R&D projects to be undertaken:

1. Base R&D program plans, to the degree possible, on defined and measurable goals.

2. Recognize that each transportation mode or technology is a part of a system.

3. Design programs, when possible, to be carried out and built upon incrementally.

4. Provide for effective management of ongoing research.

5. Provide for interaction with, as well as input and response to, the implementation process.

6. Have a strategy for disengagement.

A detailed agenda of priority areas for research is included as the Appendix to this document. It enumerates specific R&D efforts required by, or needed to support, the policy statement. Highlighted topics and technologies include construction techniques, safety and human factors, radionavigation (especially the Global Positioning System or GPS), congestion management, technology's link with productivity and competitiveness, intelligent vehicle/highway systems, magnetic levitation and high speed ground transportation, transportation data, simulation and modeling techniques, hazardous materials packaging, the environment, and energy. The process of technology transfer is also highlighted.

INTRODUCTION

This paper provides a broad policy base to support structuring a sound and effective departmental R&D program, building on the Statement of National Transportation Policy.[1] It also describes criteria for program selection and design, both for individual operating administrations in development of their R&D programs, and at the Departmental level in the crossmodal review of budget proposals.

The mission of the U.S. Department of Transportation (DOT) is to provide for "the development of national transportation policies and programs conducive to the provision of fast, safe, efficient, and convenient transportation at the lowest cost consistent therewith and with other national objectives, including the efficient utilization and conservation of the nation's resources." The services are...."to be provided by private enterprise to the maximum extent feasible.'[2]

The Statement of National Transportation Policy (the NTP), released in March 1990, set directions for the future, created a framework for Departmental programs and decisions, and identified critical strategies for action. It presented six key themes the Department's programs are designed to serve:

1. Maintain and expand the Nation's transportation system.
2. Foster a sound financial base for transportation.
3. Keep the transportation industry strong and competitive.
4. Ensure that the transportation system supports public safety and national security.
5. Protect the environment and the quality of life.
6. Advance U.S. transportation technology and expertise.

The DOT Research and Development (R&D) program is one instrument for carrying out the departmental mission. It provides a mechanism to explore new technologies and operating options, and improve existing systems and operations. The R&D program supports all the themes of the policy statement to some degree. In addition, the DOT R&D program is the key channel through which the Department supports the sixth theme of advancing U.S. technology and expertise.

Included as an appendix is an R&D Program Agenda developed from commitments in the policy statement. It indicates activities that appear to be of high priority at the present time. This list can assist officials in screening potential R&D activities during budget and program review processes. The Agenda may change as R&D efforts are concluded, new problems or priorities emerge, or new opportunities need to be explored.

MAJOR R&D POLICY PRINCIPLES

The payoff of investment in transportation R&D must compare favorably with that of other alternatives. Resources are scarce, and R&D competes with other avenues for investment by the Department in achieving its overall mission. It is important for DOT's R&D managers to make the purpose and payoff of their programs as visible, measurable, and focused as they can.

Careful selection of R&D to be undertaken

is critical. Attempting to solve all transportation problems simultaneously only serves to dilute the attention and resources applied to the important ones. The whole purpose of establishing priorities is to assure that programs focus on the significant problems and opportunities. The policy statement provides the basis for determining priority areas to emphasize.

DOT makes direct use of its own R&D in formulating regulations, standards, and policies in its various operating administrations. DOT's R&D also supports the operating functions of the Federal Aviation Administration (FAA) and Coast Guard. Another portion of the Department's R&D serves local, state, regional and private interests and individuals in and outside the transportation community. The Department's renewed attention to promoting effective implementation processes as part of R&D programs has important implications for selecting R&D projects.

It is DOT R&D Policy that the R&D programs undertaken by the Department be responsive to the directions established and the commitments made in the Statement of National Transportation Policy. Each of the six key themes of the policy statement implies the conduct of specific R&D efforts to support them:

1. Maintain and expand the Nation's transportation systems - will be supported by research to improve the capacity, condition, and utilization of existing transportation systems and infrastructure.

2. Foster a sound financial base for transportation - will be supported by research to develop and test innovative approaches to public, joint, and private financing of transportation, assess the public and private benefits of existing funding options, and promote private sector investment.

3. Keep the transportation industry strong and competitive - will be supported by research to develop and evaluate operational techniques to reduce costs, promote competition in and across modes, and foster U.S. transportation industry competitiveness in the international market.

4. Ensure that the transportation system supports public safety and national security - will be supported by research to reduce the risk and severity of accidents and casualties in individual modes and across modes, maintain national security (including interdiction and control of illegal drugs and assuring availability of needed energy and other resources in emergencies), and maintain the security of transportation passengers.

5. Protect the environment and the quality of life - will be supported by research on means to minimize the adverse impacts of transportation operations and facilities, to conserve energy and protect natural resources, and enhance transportation access and quality of life for all.

6. Advance U.S. transportation technology and expertise - will be supported by research to develop, evaluate, and permit realization of technological advances in transportation and supporting

technologies, as well as innovative approaches for operations, management, data and planning.

A more detailed elaboration of specific research initiatives in support of the policy statement is included in the R&D Program Agenda attached as the Appendix to this document.

It is DOT R&D policy that the selection and design of R&D programs include consideration of the potential users and problems involved in applying the outputs of that R&D. This includes clear definition of the likely users of products resulting from research, the needs of those users, the criteria and constraints that will dominate their implementation decision (including the source[s] of funds for implementation), and the alternatives available to fund system implementation. The benefits of new technologies are unattainable if the options are unworkable in an operational environment, or no resources are available to finance application.

Implementation of the results of research and development activities is generally a long term process. Therefore, in considering a proposed R&D investment, the probable (and possible) future operational environment should be noted along with present constraints. For a development expected to be operational in a particular time period, a view of the possible circumstances that will exist at that time should be the backdrop for decision making. Effective strategic planning, taking into account both anticipated conditions and priorities, thereby supports effective R&D program development. The policy statement commits the Department to better use of strategic planning and management processes [NTP Page 125].

Innovative financing approaches may prove key to the implementation of some new technologies, and as such are especially important. The policy statement calls for the Department to "encourage State and local governments to make use of innovative financing and funding options for transportation to supplement more conventional sources of funds, for example, joint public-private initiatives, benefit assessments on property owners, joint development rights, and other means for capturing the value of transportation projects [NTP Page 57]."

In addition to funding, the scarcity of energy and other resources necessary for system implementation will affect the implementation potential of future systems. In this light, new systems are inherently more desirable if they do not require dependency on outside parties for energy resources, or if materials in short supply or of high cost are not necessary to bring them to operation. Even significant advantages in a system's operational performance may be outweighed by the lack of key resources (energy or other kinds) necessary to construct or operate the system.

Failure to diligently assess future implementation conditions leads to at least two kinds of traps. First, an R&D program can be initiated which requires, for implementation and deployment, the future expenditure of resources that are not likely to be available. There may then be pressure to deploy the operational system components using whatever funding is available, including R&D funding. In the worst case, this leads to Federal hardware procurement, such as ordering an excessive number of "prototypes," as the last stage of an R&D effort. This is to be avoided. Second, R&D projects may be proposed simply to obtain a very short term benefit, and then may set a precedent for future

Federal involvement in an area that is not a Federal policy interest. Both possibilities underline the need for the users of the R&D to be identified, along with a method of transferring responsibility for R&D implementation to them.

It is DOT R&D Policy to conduct the necessary R&D to support the Department's operational missions. The Department must uphold its commitment to identify and make effective use of the specialized equipment and knowledge to support the Department's operating responsibilities, most notably in the Coast Guard and the FAA. The DOT must develop its own equipment to support operational missions when the size of the potential market or the degree of developmental risk is such that the private sector is not stimulated to provide needed equipment.

Development and prototype testing of specialized hardware to meet DOT needs are important parts of our R&D efforts. Procurement of developed hardware for operational use is not an appropriate use of R&D funds.

It is DOT R&D Policy to conduct R&D projects whose objective is to improve the quality of transportation decisions by the Department and the transportation community. R&D can supply objective knowledge to support regulation and policy development, both within the Department and at other levels of government. Sound regulations and policies must be formulated based on accurate and complete facts. R&D is one mechanism for obtaining them. R&D may be appropriate even when information is already available, if there is doubt as to the completeness or accuracy of the existing information.

The Statement of National Transportation Policy makes this observation:

> DOT is in the best position to provide leadership in identifying transportation data needs; assuring that essential data needs are met effectively and efficiently; developing improved analytical techniques for applying data and carrying out informed transportation planning and decisionmaking; and encouraging the dissemination of data, analytical methods, and information systems technology among State and local governments, private industry, and other research and educational institutions [NTP Page 112].

In this area, it is important that work to improve transportation decision-making be carefully planned to avoid duplicating or discouraging private sector activities on the same topics.

It is DOT R&D Policy to conduct appropriate R&D projects to stimulate action by the private sector, particularly in terms of demonstrating the market for, or applicability of, new technologies. Federally-supported operational tests of new technologies can be justified to evaluate new options and obtain knowledge about them not available any other way. Such activities also are appropriate to stimulate private sector interest to extend development of these options. Research of this type may also facilitate proper consideration of these options in implementation decisions. Federal involvement in operational trials of intelligent vehicle/highway systems (IVHS) illustrates this policy.

Operational tests are one element of a broader set of approaches to promote private sector involvement in development and implementation of new systems. The

Statement of National Transportation Policy notes this:

> The Federal Government can help to focus the attention and energy of the public and private sectors on the importance of advances in transportation for the Nation's future. By encouraging transportation research, offering seed money, and preserving tax incentives for research, the Federal Government can create the climate for research and innovation. The Department's sponsorship and funding can also help attract broader involvement in the effort [NTP Page 104].

The need for Federal R&D can be reduced if impediments to private sector involvement and the efficient working of market mechanisms can be alleviated by changes in regulatory, patent, antitrust, tax, or other policies. Assistance in defining markets to increase potential profit can also promote private investment. In general, mechanisms to stimulate financial health and innovative management by private parties in transportation decrease the need for Federal R&D, and ultimately the need for Federal involvement.

Cooperative public/private ventures also promote competition and innovation. The Statement of National Transportation Policy elaborates on this:

> Cooperative agreements for research can help all the members of the transportation community to contribute to funding research and increase the payback from transportation research activity. Most cooperative ventures in the private sector to develop new technology are not at risk of violating federal antitrust laws. If, however, it becomes clear that greater security will be required for U.S. firms to enter such productive joint ventures, the Federal Government will examine legislative and administrative remedies for fostering efforts that can reinforce U.S. competitiveness in the world market, without harming competition and the interest of consumers [NTP Page 104].

In some cases, the benefits of conducting research cannot be captured by a U.S. firm when competing in international markets. The Statement of National Transportation Policy observes this:

> Particularly where the benefits of investment in research and development would accrue beyond an individual firm, there is little incentive for a single firm to undertake a research project on its own. Frequently U.S. firms are competing with foreign firms or consortia whose research activities are at least in part subsidized by their governments. To assure the viability and technological competitiveness of the U.S. transportation industry, its customers and suppliers, some additional steps may be required to foster research efforts in this country [NTP Page 104].

It is DOT R&D Policy to structure an R&D program, both for each operating administration and Department-wide, that reflects a balance between meeting short-term needs and providing longer term options for system development. The Department must weigh addressing short-term regulatory and operational needs against developing future options. The pressure for short-term payoff is great. There is a strong temptation to eliminate longer-term oriented research items in times of fiscal austerity, and to leave it to the private sector to address them.

However, at least a limited amount of government R&D should always be oriented toward establishing technological building blocks for future systems. These programs should be undertaken even though the estimation of their payoff is difficult.

For longer-term concepts, there may be no definable customer as yet with whom the private sector can interact. Some transport concepts require the creation of institutions that do not now exist, or expansion of the scope of authority of existing institutions. Under such circumstances, the pace of innovation is likely to be very slow. In such cases, state-level mechanisms may evolve to accelerate the process. Federal stimulus to private initiative may be appropriate if speeding the process beyond that is deemed beneficial.

It is DOT R&D Policy to focus its R&D resources on projects that are wise investments: i.e. whose potential impacts or benefits are greater than the costs associated with pursuing the research. This does not mean that research projects undertaken will necessarily be low-risk. Research, by its nature, has an uncertain outcome. Any overall benefit of R&D activities is conditional on success of the research portion even before considering whether the product of the R&D can or will be put into operational use.

Research is an up-front cost of any operating system, and its benefits are usually realized only many years thereafter. The normal discounting process often results in a present value for research that discourages private investment in R&D.

In large measure, the low- risk, high or immediate payoff R&D will be done by the private sector. However, when the likely payoff to an individual company or interest is less certain, or smaller, the Federal role must often be to take part in or initiate the higher risk ventures. In addition, some research impacts are particularly hard to quantify: in safety projects directed at saving lives, it is difficult and uncomfortable to place dollar values on the lives saved. Considering these things, high-risk, high cost, and long lead time to realize a return are three factors that often drive a call for Federal funding over private sector funding.

There is no simple method for establishing that benefits of conducting R&D outweigh its costs, so assessing the cost-effectiveness or prudence of a Federal research investment is often highly judgmental. All costs and all benefits, both external and internal, should be considered. Quantification is desirable, but inability to quantify relevant factors does not decrease their importance. Purely qualitative rationales also may be necessary and useful.

The Department should avoid pursuing R&D if there is evidence that other approaches to achieve the same benefit, such as regulation or legislation, would be more efficient or involve lower costs.

It is DOT R&D Policy to assure that appropriate mechanisms exist for the management of the Department's R&D program to promote effectiveness and reduce duplication. One of the major vehicles to accomplish this has historically been the Department's Research and Development Coordinating Council. Chaired by the Research and Special Programs Administrator, it consists of the Associate Administrators for R&D (or similar position) from each of the operating administrations in the Department. The Council provides a forum to share information on the conduct and status of

research and development efforts, and to advocate effective technical program development in the Department.

The primary role of the Council is coordinative in nature. Agency administrators have the duty to advise the Secretary of what support they need to fulfill their regulatory and operational responsibilities. The Council provides backup to them in this role: it provides a Departmental, crosscutting perspective on technical issues to the officials the administrators have entrusted with formulation of R&D programs.

The recommendations of the Council are implemented by each of the individual administrations acting through their own programs. This reflects the importance for organizations or individuals to have the authority to effectively carry out a research program, and be held accountable for program performance.

A key role of the Council in the future will be coordinating projects to develop "generic" technologies or knowledge with multimodal applicability. The Statement of National Transportation Policy, for example, commits the Department to a coordinated program of research on human factors. Council activities will be essential to an effective program. More broadly, the Council will assure that the research commitments in the policy statement are addressed.

Whether through the present mechanisms, or through different management channels, the cross-modal coordination of technical program development among the agencies and offices in DOT must occur.

In addition to coordination within the Department, the development of DOT's research should be coordinated, in at least general terms, with the R&D programs of other Federal agencies. The current vehicle for this is the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET). In particular, development of transportation systems ultimately affects energy use, regional development, climate and environment, and a wide range of societal factors. The Department needs to be sure that the transportation R&D choices it makes support national goals for energy independence, national competitiveness, environmental quality, and other crosscutting concerns.

It is DOT R&D Policy to provide for mechanisms to disseminate and promote the application of the results of its research activities as part of the overall R&D management process. This includes formal technical assistance/technology sharing activities, either integrated with the research projects themselves, or conducted as support to the R&D programs. The varied activities of DOT's Federal Highway Administration (FHWA), which has emphasized the topic of research implementation or technology application for years, are a model in this area, government-wide. FHWA's work includes development of technical briefs, summary documents on technology advances, direct assistance through a network of technology transfer centers in the field, and a wide range of training courses and packages.

The Statement of National Transportation Policy gives this area explicit emphasis:

> It is Federal transportation policy to...make Federal transportation data, research findings, and information on technology and innovation in transportation available to researchers, industry, and all levels of government [NTP Page 105], and,

> It is Federal transportation policy to...promote adoption of new technologies and reassert U.S. international technical leadership in transportation by fostering increased awareness of and interest in research and development activities [NTP Page 105].

A specific initiative is proposed in the policy statement's Short-Term Program Agenda to accomplish this:

> To promote new transportation research and development that will advance U.S. technology and support an improved transportation system, the Department will...restructure the Department's program of technical assistance and technology sharing to more effectively support State and local decisionmaking on present and advanced systems, particularly with information on innovative funding approaches [NTP Page 124].

Transfer of technical findings on an issue to other Federal agencies dealing with that same issue can be particularly important. It helps reduce unwarranted duplication of effort, and promotes more consistent, enlightened treatment of issues on an interagency basis.

In projects with the private sector, the issue of intellectual property and possible patents resulting from discoveries funded or partly funded by DOT-sponsored research must be dealt with early in a project. Private participants in joint public/private R&D efforts will be concerned about the rights to patents emerging from the work. To improve the prospects for a technology's effective completion and application, the Federal government must be careful not to hold patent rights too closely or disseminate discoveries too broadly in those projects. Any public-private efforts undertaken should define the conducting firm's rights clearly and explicitly before the initiation of any project.

DESIGN CRITERIA FOR R&D PROGRAMS

In designing projects to address specific R&D needs, general guidelines are needed to assure a useful output from the effort. These guidelines are applicable to almost any kind of research to be undertaken:

1. Base R&D plans, to the degree possible, on defined and measurable goals.

   Where it is practical and meaningful, desired results should be translated into quantitative and measurable terms. The goal selected should be a realistic vision of an output against which a program's progress can be evaluated. The goals should be a considered estimate of what is achievable with the available time and money, at the accepted risk.

2. Recognize that each transportation mode or technology is a part of a system.

   The Department needs to recognize that all the operational elements of transportation technology that result from its support of R&D must ultimately work together as a system. Each R&D program must, therefore, recognize interface requirements of its products with other system elements. This emphasizes the importance of keeping up an ongoing technical dialogue with other relevant programs, both inside and outside DOT. Again the Department should depend first on

the private sector in evolving technological and other improvements, but can help foster the necessary improvements.

3. Design programs, when possible, to be carried out incrementally.

R&D programs should be designed so that small amounts of money can be spent initially establishing the feasibility of a particular technical approach before additional steps and larger expenditures are devoted to long term research and development.

4. Provide for effective management of ongoing research.

R&D programs should be tightly managed to assure that they meet clearly established deadlines. The programs need to have specified milestones when evaluations are performed to determine if the program should proceed, and, if so, what changes need to be made.

5. Provide interaction with the implementation process.

R&D plans must ensure appropriate interaction between those conducting the research and those who will decide whether or not to go forward with the research products. This requires explicit consideration of the process of making research information available to its ultimate users in useful form: technology sharing and application. The planning for any research and development effort must include mechanisms and processes for sharing the results of the research, and for R&D program managers to reach out to potential users for input and feedback.

6. Have a strategy for disengagement.

Research plans should include strategies to end Federal involvement if the research is successful and the results can be efficiently carried forward by other parties, or if deviations from plan or new knowledge reduce the potential benefit of the research to an unacceptable level. Criteria for making such determinations should be developed as part of the initial design and planning for a research program.

By its very nature, research is frequently unpredictable both in terms of progress and outcome. The concept of accountability is essential, but the accountability must be for diligence in pursuing the project and evaluating its progress as it proceeds, rather than strictly for its ultimate success. Researchers must be encouraged to report early if a particular line of pursuit is not paying off, and to recommend cutting losses by adjusting or terminating the project.

CONCLUSION

The nation's transportation future depends on continued transportation related R&D. The Federal Government must work to promote creativity and imagination in developing, adopting and promoting new technologies and operational options to keep America's transportation system at a high level of service and safety. By pursuing this R&D Policy, the Department will be supporting the directions set forth in the Statement of National Transportation Policy, and contributing to the economic and social goals of this country.

This also provides leadership in a key area

of national interest, as noted in the U.S. Technology Policy.[3]

> This [transportation] R&D is aimed at maintaining a modern, efficient transportation infrastructure, an essential factor in being industrially competitive.

The rewards from this kind of leadership can be great, as the Statement of National Transportation Policy observes:

> The Federal Government...can serve as a leader and a catalyst for research, innovation, and expertise. From the increased interest in advances in the transportation field and corresponding creative and technological resources drawn to transportation, the Nation will long reap the benefits of rising productivity and competitiveness and an enhanced quality of life [NTP Page 102].

1. Moving America: New Directions, New Opportunities, Volume 2, A Statement of National Transportation Policy, Strategies for Action; U.S. Department of Transportation; Washington, D.C.; February 1990. (referred to as the policy statement or the NTP throughout this statement).

2. Public Law 89-670, October 15, 1966 (DOT Act).

3. U.S. Technology Policy, Executive Office of the President, Office of Science and Technology Policy; Washington, D.C.; September 26, 1990

APPENDIX
R&D PROGRAM AGENDA

The Statement of National Transportation Policy includes a variety of commitments in technical fields, both to specific R&D and to other initiatives which will require associated research. These areas will be particularly important to the Department, and must be highlighted in the Department's technical program development efforts. The areas are listed below, under each of the themes they are associated with:

1. Maintain and Expand the Nation's Transportation System

   The investment in our existing transportation facilities must be protected. Efforts must include strategies to increase capacity and reduce congestion while seeking new avenues to provide new links in today's intermodal networks. DOT sponsorship of research in the following areas is therefore appropriate:

   - o Evolve new materials, and more sophisticated techniques for infrastructure preservation through pavement, bridge, and other facilities management programs [NTP Page 46].
   - o Develop improved designs and techniques to resist or counter the effects of wear or damage to bridges, reinforcing structures, and other transportation facilities [NTP Page 46].
   - o Develop techniques to deal with damage to transportation facilities from weather, corrosion, natural disasters, and other causes [NTP Page 46].
   - o Test alternative options and management techniques to enhance performance and capacity of existing infrastructure, such as HOV techniques, traffic control improvements, and other low-cost strategies to reduce overall congestion [NTP Page 49].
   - o Improve vehicle control and scheduling techniques for complex and multiple use transportation facilities, such as waterways, harbors, rail lines, intermodal terminals, and national space launch ranges [NTP Page 49].
   - o Experiment with peak-period and congestion pricing to ensure the most effective use of transportation facilities [NTP Page 49].
   - o Develop design techniques for improved multimodal facilities and improved transfer techniques between modes [NTP Page 51].
   - o Develop more efficient transportation services for rural areas to better connect them to higher density areas, improving safety and making appropriate use of the private sector [NTP Page 51].
   - o Develop and refine alternatives analysis and preliminary engineering techniques used to assure that essential new capacity is provided in transportation systems of national significance [NTP Page 53].
   - o Develop and improve techniques to conduct multimodal assessments of needs for investment or increases in

transportation system capacity [NTP Page 53].

2. Foster a sound financial base for transportation

The Department's R&D programs must examine the full range of traditional and non-traditional financing approaches. Reasonable public expenditures, supplemented by creative private investment, can support implementation of needed transportation alternatives and facilities. DOT sponsorship of research in the following areas is therefore appropriate:

- o Continue experimentation with innovative financing techniques, especially those drawing their effectiveness from value capture approaches around intermodal and multimodal facilities and use of public/private partnerships to leverage investment [NTP Page 57].

- o Conduct projects to encourage state and local governments to apply innovative financing and funding options, especially joint development at transit stations, terminals, park and ride facilities, and administrative facilities [NTP Page 57].

- o Continue experimentation with private sector funding of key transportation facilities, and techniques to promote public/private cooperation in transportation [NTP Page 59].

3. Keep the transportation industry strong and competitive

The Department must identify measures which contribute to effective competition, efficient operations, and a healthy and sound transportation industry. Equitable government treatment of carriers and all modes of transportation must be encouraged, along with effective standards for handling and exchange of traffic and billing information. Legislative, regulatory, and administrative measures must be evaluated, particularly with regard to reinforcing U.S. competitiveness in the world market, and at the same time protecting the interests of consumers. DOT sponsorship of research in the following areas is therefore appropriate:

- o Develop more efficient and lower cost techniques to maintain transit facilities and equipment [NTP Page 63].

- o Develop information base to support informed decision making on high-speed rail and maglev systems [NTP Page 66].

- o Continue research to improve safety of general aviation operations [NTP Page 66].

- o Conduct research into reliever airport concepts for use by general aviation [NTP Page 66].

- o Monitor and evaluate the operation of alternative types of space launch facilities and systems [NTP Page 68].

- o Develop techniques to help standardize domestic transportation equipment, billing, and electronic data interchange on a multimodal basis [NTP Page 72].

- o Develop uniform standards for container sizes and documentation

of international cargoes [NTP Page 72].

- o Foster development of local tools for ensuring compatible land use around airports [NTP Page 75].

- o Increase international exchange of transportation technology with emphasis on technologies which can be applied by U.S. carriers to increase their competitiveness [NTP Page 78].

- o Conduct research on enhancing a cooperative work environment in transportation, and improving labor and management performance and productivity in the transportation industry [NTP Page 80].

- o Conduct cooperative projects with transportation companies, universities, and the private sector to develop and test specialized programs for training transportation personnel at all levels [NTP Page 80].

- o Develop options for improved personnel support systems, including recruitment and training, for high-skill Federal transportation positions [NTP Page 80].

. Ensure that the Transportation System Supports Public Safety and National Security

Safety considerations must always be addressed in the transportation development and operations process. Measures must be developed for existing and emerging systems and operations to protect the traveling public from harm or injury both from internal and external forces. This includes maintaining needed supplies of energy and other resources during national emergencies. DOT sponsorship of research in the following areas is therefore appropriate:

- o Compile/expand multimodal data on transportation accidents [NTP Page 82].

- o Develop necessary data to allow review of new designs for transportation vehicles to detect safety problems [NTP Page 82].

- o Experiment with alternative approaches for assuring and improving pedestrian safety [NTP Page 85].

- o Develop new engineering standards and signing systems to promote safer design and maintenance of highway systems [NTP Page 85].

- o Continue experimentation with ways to promote more effective enforcement of laws and regulations governing speed limits, motor carrier safety, drunk and drugged driving, and use of safety belts, child safety seats, and motorcycle helmets [NTP Page 85].

- o Undertake a comprehensive program of human factors research and apply the results to improving technology, training, and procedures [NTP Page 87].

- o Conduct necessary R&D to maintain a strong and effective Coast Guard to protect life and property in maritime environment, including search and rescue capability [NTP Page 88].

- o Develop technology for improved

navigational aids and Marine Vessel Traffic Systems to guide and control ship movements [NTP Page 89].

- o Develop approaches to improve safety and security of public transportation systems, including anti-substance abuse programs, safety standards, and improved safety training [NTP Page 90].

- o Develop techniques to improve safety including monitoring and safety enforcement for railroad track, equipment, and operations [NTP Page 90].

- o Develop technologies to improve the efficiency and quality of pipeline inspection and enforcement activities [NTP Page 90].

- o Compile hazardous materials transportation data across all modes to identify potential safety problems [NTP Page 91].

- o Develop effective hazardous materials regulation, enforcement, and preparedness strategies to deal with evolving materials and technologies [NTP Page 91].

- o Develop data to reorient hazardous materials packaging standards to be based on performance criteria, rather than detailed design specifications [NTP Page 91].

- o Identify and periodically update an integrated multimodal strategic transportation network, including a full inventory of defense essential facilities, vessels, and vehicles, and a comprehensive data base providing information on their condition and location in the system, using the resources of the Departments of Defense and Transportation [NTP Page 94].

- o Develop forecasts of future defense transportation requirements, and establish priorities among them [NTP Page 94].

- o Develop techniques to maintain Coast Guard surveillance on and over the waters to interdict illicit drugs coming from other countries to U.S. shores [NTP Page 94].

- o Develop techniques to assist in reducing illegal drug traffic moving on the nation's transportation system, including the highway, aviation, maritime, and railroad systems [NTP Page 94].

- o Develop and improve technologies to assure effective screening of passengers and cargoes at international airports [NTP Page 95].

- o Develop approaches to assess vulnerability of ports, terminals, and other facilities, and improve physical security against terrorism and criminal acts [NTP Page 95].

5. Protect the Environment and Quality of Life

Environmental considerations must be addressed early in the process of developing new transportation systems and other options. They must also be part of the decision-making process at all levels during the construction, operation, and maintenance of transportation systems and facilities. The Federal Government must provide leadership in protecting our natural

resources for future generations while stimulating private interests to develop more energy efficient and environmentally safe systems. DOT sponsorship of research in the following areas is therefore appropriate:

- Develop approaches to help urban areas meet the requirements of the Clean Air Act Amendments, including alternative fuels, innovative propulsion systems, and innovative enforcement activities [NTP Page 97].

- Participate in national and international reviews of, and research on, transportation-related environmental issues, such as global climatic change [NTP Page 97].

- Develop improved facility design techniques to fit new construction more harmoniously into communities and the natural environment [NTP Page 97].

- Develop improved and more consistent contingency planning procedures to respond to oil spills [NTP Page 99].

- Assemble information to develop a strategy to assure the safe transport of crude oil and petroleum products, including vessel design, shipping lane and vessel traffic control requirements, and transloading operations, considering new technology and changing shipping patterns [NTP Page 99].

- Conduct a study of oil tank ship design, including an assessment of the benefits of double bottom and double hull design [NTP Page 99].

- Explore the costs and benefits of stricter regulation of loading and unloading oil shipments at shoreline docks in comparison to alternatives such as additional private sector deepwater offshore loading facilities [NTP Page 99].

- Foster development and use of more fuel-efficient vehicles and transportation operations [NTP Page 100].

- Develop technological improvements and design criteria to promote improved accessibility of the elderly and handicapped to urban, rural, and intercity transportation services [NTP Page 101].

- Develop improvements in standardized signs and passenger information services to facilitate use of airports and passenger terminals by their patrons [NTP Page 102].

6. Advance U.S. Transportation Technology and Expertise

The transportation system faces challenges and demands that will require increasing knowledge and technological advances. Technical expertise and improved data collection devices and services must be developed and nurtured to deal with the demands of the next century. DOT sponsorship of research in the following areas is therefore appropriate:

- Conduct research to improve the capabilities and applicability of radionavigation systems to check the position of vehicles and cargoes in the air, on the highways and railroads, and in shipping lanes,

including the satellite-based Global Positioning System (GPS) [NTP Pages 18, 103].

- Conduct cooperative research efforts with the transportation industry to develop innovative approaches for transportation systems and technology [NTP Page 104].

- Conduct a comprehensive research program on human factors in transportation, including the causes of transportation accidents and the effects of operator impairment, perceptual errors and fatigue, as well as design and operating changes that can eliminate or reduce those effects [NTP Page 105].

- Continue research on improvements in design and operation of existing vehicles and transportation systems [NTP Page 105].

- Assess the feasibility of new transportation systems and technologies, providing seed money for research as necessary [NTP Page 105].

- Develop approaches to ensure that regulatory and institutional barriers do not impede implementation of viable new technologies [NTP Page 105].

- Conduct research in transportation at the country's universities and research institutions addressing transportation issues, problems, and needs [NTP Page 105].

- Experiment with innovative ways to make Federal transportation data, research findings, and information on technology and innovation in transportation avalable to researchers, industry, and all levels of government [NTP Page 105].

- Promote adoption of new technologies and reassert U.S. international technical leadership in transportation by fostering increased awareness of and interest in research and development activities [NTP Page 105].

- Conduct and/or stimulate private sector action to develop an effective intercity transportation option for use in trips of 200 to 500 miles: specifically consider maglev and tiltrotor systems as options [NTP Page 106].

- Evolve a coordinated interagency program to develop motor vehicle systems that will be safer, more environmentally benign, and lower in energy consumption, without compromising basic mobility, industrial competitiveness, or standard of living [NTP Page 107].

- Develop an integrated program of research and development for Intelligent Vehicle/Highway Systems, including personal vehicles, motor carriers, and public transportation [NTP Page 108].

- Conduct necessary research to assemble data to support timely, informed Federal, State, local, and regional transportation planning and decisionmaking [NTP Page 113].

- Develop more consistent standards for data collection and tabulation across all modes and users of transportation [NTP Page 113].

- o Collect and disseminate information on the quality of transportation service, such as airline on-time performance, to increase awareness of service conditions and needs for improvement [NTP Page 113].

- o Conduct necessary research to establish a baseline for decision-making on future systems through the Department's strategic planning process [NTP Page 113].

In addition to these items, initiatives can be undertaken to improve the dissemination, or promote the application of, the final products of the efforts described here. The full range of such options should be examined in the planning of any research which addresses the priority issues noted.

UNIVERSITY OF CALIFORNIA, BERKELEY

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Institute of Transportation Studies

Program on Advanced Technology
for the Highway (PATH)
Richmond Field Station,
1301 S. 46th St., Bldg. 452,
Richmond, CA 94804
TEL: (415) 231-9495 FAX: 231-9565

April 17, 1991

Mr. Nelson Milder
The American Society of Mechanical Engineers
1825 K Street, Suite 218
Washington, DC 20006-1202

Dear Nelson:

At the April 16 hearing of the Subcommittee on Technology and Competitiveness of the House Committee on Science, Space and Technology, Chairman Valentine raised some questions with the second panel of witnesses that I believe deserve more complete answers than they received. The Chairman's questions go to the heart of some of the important issues associated with IVHS, particularly the advanced vehicle control technologies, and therefore must be answered thoughtfully.

(1) Aren't collision avoidance and fully automated vehicle systems terribly expensive?

All new technologies tend to be very expensive when they are first produced in very limited quantities, but electronics technologies in particular become much less expensive once they are produced in large quantities. Today's mid-range home video cassette recorder is a remarkably complicated device, and a device with its capabilities would have been extremely costly even ten years ago, if it could have been made available at all. Even more dramatically, I am compelled to recall my first encounter with an electronic pocket calculator exactly twenty years ago. It could perform only four functions (add, subtract, multiply, divide) and cost $300, but was regarded as a marvel at that time, when engineers were still using slide rules and massive electromechanical adding machines. Within just a handful of years, four-function calculators were nearly being given away and full-function scientific calculators became available for less than $50. The point, of course, is that the unit costs of even extremely complicated electronic devices can be brought down to very low levels.

The experience of the automotive industry with electronic engine controls is perhaps even more directly relevant. Most people do not realize that the engines on all modern automobiles are controlled by very sophisticated computer systems. The first experimental versions of engine control computers about twenty years ago were so bulky and heavy that they could not fit into the test cars, but had to be towed behind them in trailers. Today's engine controllers, which are much more capable, fit into a package about the size of a paperback book and generally cost no more than a high quality car radio.

The most advanced vehicle control devices will come into use at a late stage in the evolution of IVHS technology, after the less advanced systems have been developed, placed in service and produced in large quantities so that the costs of their components have been brought down. Those can then serve as building blocks for the more advanced systems (proceeding from collision warning devices to collision avoidance devices and adaptive cruise control and then to fully automatic speed and spacing control).

The cost of any AVCS system cannot be considered in isolation from the costs of all the alternatives, including doing nothing. If we are to leave the road system in its current condition, without applying the new technologies, then we must evaluate the costs of congestion and accidents that will be incurred as the demands on the system increase. If we are to expand system capacity by adding more lanes using conventional technology, then we must consider the cost of construction of those lanes (which is likely to be very high in the most congested locations, where they are most needed). In either case, the costs of these alternatives are likely to be higher than the (possibly high) cost of implementing and operating an automated vehicle system.

(2) How can these devices be any better than the brain of the driver?

Even the most sophisticated electronic devices cannot approach the human brain for certain types of activities, involving judgmental decision making or pattern recognition. However, electronic devices can perform some sensing or detection functions much more quickly than humans can, and can respond to stimuli more quickly as well. Collision warning or avoidance systems, as well as fully automated vehicle systems, are intended to capitalize on these enhanced sensing and response speeds of electronic devices to enable vehicles to avoid accidents that human drivers could not avoid or to operate more closely together than human drivers could do safely.

Various studies have shown that average drivers today are not operating at safe spacings from the vehicles in front of them, but are following so closely that they are prone to suffer rear-end collisions if something goes wrong with the front vehicle. In order to improve safety, these vehicles would have to operate at larger specings, which would reduce the capacity of each lane. Use of the advanced vehicle control technologies makes it possible to improve safety and increase capacity at the same time, by clustering vehicles in "platoons" at very close spacings and using high-performance control systems to respond to any abnormalities that occur.

(3) Does the United States suffer from some natural disadvantages relative to Europe and Japan, which would impair our ability to make use of IVHS?

The question appeared to be oriented towards differences in the transportation networks and patterns of development (concentrated relative to sprawled). While these are certainly important differences, there are even larger differences in a couple of other dimensions, which may have even more profound ramifications for the eventual success of IVHS in the United States. The first of these is the lack of a strong culture of government-industry cooperation, which will be needed to make IVHS development, deployment and operation succeed. Significant progress is being made on that front with the establishment of IVHS America. The more serious problem area is associated with the short planning horizon of American institutions (both public and private) compared to their European and Japanese counterparts.

The problem of short planning horizons is an extremely serious one throughout the entire American economy, since it always tends to discourage investment in research and development, particularly on the most innovative technologies. We have already seen the consequences of this in the loss of international leadership in a variety of industries, from steel to consumer electronics. Unfortunately, much of this myopia is imposed on industry by the investment community, which focuses its attention on quarterly and annual earnings reports rather than on the investments that companies are making for the future. The federal government cannot do much to influence this, but it can ensure that the commitments that it makes to public-private partnerships for advanced surface transportation systems are stable and valid over a period of several years. The private sector cannot make a rational commitment of its resources to a long-term development program if there is significant uncertainty about the solidity of the commitment of its public sector counterpart.

(4) Would anybody want to give up control of their car to an automated system?

There is bound to be a variety of perspectives on this; some people will be very reluctant to give up any of their decision or control authority, while others will welcome the relief from the chore of driving in rush-hour traffic. Any automated system would have to be voluntary rather than mandatory, so that all drivers can exercise their choice. When an automated freeway lane first becomes available, it will offer travel at the speed limit to anybody who chooses to use it, while those who prefer not to use it will continue to experience the congested travel of conventional roads. That disparity may well convince some of the skeptics to try the automated experience, and when they find that they can make double use of their travel time (for reading, writing or other non-driving activities) they may choose to stay with the new technology approach. As more drivers choose to use the automated highway, they will tend to relieve some of the congestion on the conventional highways, or at least prevent it from becoming even worse, so that in fact everybody benefits, both users and non-users.

I hope that these answers help clarify some of the important issues affecting IVHS, which I believe should be brought to the attention of the Committee. I hope that the substance of these answers can be entered into the record of the hearing even though these questions were not asked when I was at the witness table. Thank you very much for your help in this matter.

Sincerely yours,

Steven E. Shladover

Steven E. Shladover
PATH Technical Director

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A LAND-GRANT UNIVERSITY

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

UNIVERSITY CENTER FOR TRANSPORTATION RESEARCH • 106 FACULTY STREET

PH. (703) 231-7740
FAX (703) 231-7532
TELEX 910-333-1861

May 7, 1991

The Honorable Tim Valentine, Chairman
Subcommittee on Technology
and Competitiveness
U.S. House of Representatives
Committee on Science, Space,
and Technology
Suite 2320 Rayburn House Office Building
Washington, DC 20515

Dear Congressman Valentine:

Thank you again for inviting me to appear before the U.S. House of Representatives Subcommittee on Technology and Competitiveness. The subject of Intelligent Vehicle/Highway Systems has recently gained public attention, and most of the public comments have been favorable. Similar to the car cellular telephone, I expect that IVHS technologies will experience the same explosion in demand, once drivers realize their benefits. Since IVHS crosses many disciplines, all involved professional societies have publicly supported the development of these technologies.

On the other hand, I also believe that IVHS is not the answer to all of our transportation problems. Several of these problems lie in the administrative and financial structure we have in this country. We still treat transportation problems by modal entities as unrelated compartments such as highways, transit, railroads, airports, etc. Until we take the approach of integrating the modal administrations to solve the urban, rural, and intercity transportation problems, in a unified and systematic way, we will not be able to reach balanced, comprehensive and efficient transportation system.

I have sent Ms. Sherri Stone a copy of the corrected transcript of my oral testimony. Again, it has been a pleasure testifying before the Subcommittee and I will be glad to do it again if the need arises.

Sincerely,

Antoine G. Hobeika, Ph.D.
Director and Professor

AGH/thk